

RCAP RECEIVED
AUG 19 2011

2011 ANNUAL GROUNDWATER MONITORING REPORT

FORMER SELLER-GLOBE FACILITY
3200 MAIN STREET
KEOKUK, IOWA

Prepared for
United Technologies Corporation
Hartford, Connecticut
On behalf of Lear Corporation Automotive Systems

August 2011

URS

URS Corporation
8300 College Blvd., Suite 200
Overland Park, KS 66210
913-344-1000
16530531

511565



RCRA



August 18, 2011
URS Project 16530531

RCAP RECEIVED
AUG 19 2011

Ms. Lynn Slugantz
Branch Chief
U.S. EPA Region 7
ARTD/RCAP
901 North 5th Street
Kansas City, Kansas 66101

RE: 2011 Annual Groundwater Monitoring Report
Former Sheller-Globe Facility at 3200 Main Street, Keokuk, Iowa

Dear Ms. Slugantz:

Enclosed is the 2011 Annual Groundwater Monitoring Report for the referenced site. This report is submitted on behalf of United Technologies Corporation (UTC) and Henniges Automotive (formerly Metzeler Automotive Profile Systems Iowa, Inc.), jointly referred to as "Respondents", in accordance with the Administrative Order on Consent RCRA-07-2007-0009 (the "Order").

Please contact Bryan Kielbania at UTC if you have any questions or comments. He can be reached at (860) 728-6503.

Very truly yours,
URS Corporation

David A. Dods
Project Manager

Charles L. Arthur
Project Scientist

Enclosure

cc: Bryan Kielbania (UTC)
Joe Gregg, Esq. (Eastman and Smith)
Shawn McAfee (Henniges Automotive)
Dale Guariglia, Esq. (Bryan Cave LLP)
Mark Allen (SAS Environmental)
Chris Tedder (MACTEC)

2011 ANNUAL GROUNDWATER MONITORING REPORT

FORMER SELLER-GLOBE FACILITY
3200 MAIN STREET
KEOKUK, IOWA

Prepared for
United Technologies Corporation
Hartford, Connecticut
On behalf of Lear Corporation Automotive Systems

August 2011



URS Corporation
8300 College Blvd., Suite 200
Overland Park, KS 66210
913-344-1000
16530531

TABLE OF CONTENTS

Section 1	Introduction.....	1-1
1.1	Purpose of the Annual Groundwater Monitoring Activities.....	1-1
1.2	Report Organization.....	1-1
1.3	Site Background.....	1-1
1.3.1	Contamination Source Areas	1-1
1.3.2	Site Remedies Selected.....	1-2
1.3.3	Site Topography and Soils.....	1-2
1.3.4	Previous Source Area Control Activities.....	1-4
Section 2	Summary of 2011 Groundwater Sampling Activities and Results.....	2-1
2.1	Groundwater Elevations and Flow Directions.....	2-1
2.2	Groundwater Sampling Methods	2-1
2.3	Laboratory Analysis and Data Review Activities	2-2
2.4	2011 Annual Groundwater Monitoring Results	2-3
2.4.1	Source Area Wells	2-4
2.4.2	Primary Plume Wells.....	2-5
2.4.3	Sentinel and Property Line Wells	2-6
2.5	Natural Attenuation Evaluation	2-7
2.5.1	Natural Attenuation Mechanisms	2-8
2.5.2	Biodegradation of Volatile Organic Constituents.....	2-8
2.5.3	Behavior of VOC Plumes	2-11
2.5.4	Evidence Required to Demonstrate Natural Attenuation	2-12
2.6	Site-Specific Natural Attenuation Evaluation	2-12
2.6.1	Plume Dimensions and Contaminant Mass/Concentration Trends	2-12
2.6.2	Geochemical Indicators of Natural Attenuation	2-13
2.7	References.....	2-16
Section 3	Conclusions and Recommendations.....	3-1

Tables

Table 1	June 6, 2011 Water Levels and Groundwater Elevations
Table 2	Monitoring Well and Piezometer Construction Details
Table 3	Analytical Results for Equipment and Trip Blanks
Table 4	Analytical Results for Shallow Wells
Table 5	Analytical Results for Till Wells
Table 6	Analytical Results for Sentinel and Property Line Wells

TABLE OF CONTENTS

Appendices

Appendix A	Annual Groundwater Sample Collection Field Sheets
Appendix B	QA/QC Review Summary
Appendix C	Trend Charts and Mann-Kendall Trend Analysis Worksheets
Appendix D	CD with Laboratory Analytical Data Reports and Report Drawings
	<u>Analytical Data Reports</u>
	Accutest Job Number T78000
	Accutest Job Number T78142
	Accutest Job Number T79594
	<u>Drawings</u>
	Cover Property Line and Facility Layout
	Drawing 1 Fill Groundwater Elevation Contour Map – June 2011
	Drawing 2 Till Groundwater Elevation Contour Map – June 2011
	Drawing 3 Volatile Organic Constituents in Shallow Groundwater – June 2011
	Drawing 4 Volatile Organic Constituents in Deep Groundwater – June 2011
	Drawing 5 Total Non-Chlorinated VOCs in Groundwater – June 2011
	Drawing 6 Total Non-Chlorinated VOCs in Groundwater – April 2010
	Drawing 7 Total Chlorinated VOCs in Groundwater – June 2011
	Drawing 8 Total Chlorinated VOCs in Groundwater – April 2010
	Drawing 9 Tetrachloroethylene in Groundwater – June 2011
	Drawing 10 Trichloroethene in Groundwater – June 2011
	Drawing 11 cis-1,2-Dichloroethene in Groundwater – June 2011
	Drawing 12 Methylene Chloride in Groundwater – June 2011
	Drawing 13 Vinyl Chloride in Groundwater – June 2011
	Drawing 14 Total BTEX in Groundwater – June 2011
	Drawing 15 Cross Section A-A', Plume Centerline Wells – June 2011
	Drawing 16 Monitored Natural Attenuation Parameters – June 2011
Appendix E	Plume Attenuation/Distance Calculations

This report presents the results of the 2011 annual groundwater monitoring event performed during the week of June 6, 2011 at the former Sheller-Globe facility at 3200 Main Street in Keokuk, Iowa. The annual groundwater monitoring activities are performed to:

1. Continue monitoring natural attenuation processes at the site and verify that the primary volatile organic compound (VOC) plume in the area of monitoring well clusters MW-10 and MW-13 continues to remain stable and/or decrease over time.
2. Confirm that contamination is not migrating off-site.
3. Continue to monitor how groundwater conditions have changed in response to the source removal soil excavation activity conducted in 2007.

The findings from the 2011 sampling event include the following:

- The primary VOC plume located in the Employee Parking Lot in the vicinity of the MW-10 and MW-13 well clusters remains stable.
- VOC concentrations in sentinel well clusters (MW-17 and MW-23) and the property line wells (MW-19 and MW-20) remain below maximum contaminant levels (MCLs).
- Groundwater flow directions continue to remain consistent with historic patterns. Topographic and hydrogeologic conditions limit off-site migration of the VOC plume in the area of wells MW-10 and MW-13. The plume remains contained on-site.
- The primary VOCs in the parking lot plume continue to be methylene chloride (MC), trichloroethylene (TCE), and tetrachloroethylene (PCE). Benzene, toluene, ethyl benzene and xylene (BTEX) constituents in that area have been largely reduced due to the process related to the natural degradation of the chlorinated VOCs.
- The most significant indicators of natural attenuation at this site continue to be the presence of degradation daughter compounds. Zones of anoxic and reducing conditions which are necessary for reductive dechlorination to take place are slightly smaller than in previous years but remain present in the vicinity of the MW-10 and MW-13 well clusters.
- Since most of the BTEX compounds have been exhausted as part of the natural degradation of the chlorinated VOCs, the primary organic carbon source remaining, that may continue to support reductive dechlorination, appears to be MC. As a result, degradation rates may be slower in the future, but the chlorinated VOC plume continues to be stable and contained on-site.

The next annual sampling event is scheduled to be conducted in the spring of 2012. That will represent the fifth sampling event conducted subsequent to the source removal activities, and a five year review will be required after that event.

1.1 PURPOSE OF THE ANNUAL GROUNDWATER MONITORING ACTIVITIES

This report presents the results of the 2011 annual groundwater monitoring event performed during the week of June 6, 2011 at the former Sheller-Globe facility at 3200 Main Street in Keokuk, Iowa. The corrective measures required for the site were documented in the Final Remedy Decision (EPA, September 22, 2006), and the Administrative Order on Consent signed July 3, 2007. The corrective measures selected by the Environmental Protection Agency (EPA) included excavation of shallow VOC-contaminated soils in the area of the former underground solvent tanks (a source removal), institutional controls, and Monitored Natural Attenuation (MNA) for groundwater. The source removal soil excavation activities were conducted in July 2007.

An initial five-year groundwater monitoring period is required, at which point a five-year review will be conducted. The June 2011 groundwater sampling event was the fourth full sampling event conducted subsequent to the soil excavation/source removal activities.

The annual groundwater monitoring activities are performed to:

1. Assess whether groundwater conditions have changed in response to the source removal soil excavation activity conducted in 2007.
2. Continue monitoring natural attenuation processes at the site and verify that the primary VOC plume in the area of monitoring well clusters MW-10 and MW-13 continues to remain stable and/or decrease over time.
3. Confirm that contamination is not migrating off-site.

1.2 REPORT ORGANIZATION

Section 1.3 provides site background information and the purpose of the groundwater monitoring program.

Section 2.0 presents a summary of the groundwater sampling activities and results for the 2011 annual event, including an evaluation the natural attenuation monitoring results.

Section 3.0 presents results and conclusions.

The Appendices contain copies of field data sheets, data validation notes, statistical calculations, trend charts, plume attenuation calculations, as well as portable document format (PDF) copies of the report drawings and laboratory reports.

1.3 SITE BACKGROUND

This section summarizes background information for the site and repeats information that was first presented in the 2007 report.

1.3.1 Contamination Source Areas

The facility is located at 3200 Main Street in Keokuk, Iowa and has been utilized for the manufacture of rubber and foam rubber products since 1914. The site layout is shown on the cover drawing included in Appendix D. The site history has been documented in previous

reports for the site. Former operations at the facility resulted in the release of VOCs to soil and groundwater in a limited area of the facility. A number of environmental investigations have been conducted to evaluate the degree and extent of contamination.

The primary source of soil and groundwater contamination was five underground solvent product tanks formerly located adjacent to the east side of the Chemical Mixing Building. The five tanks were removed in October 1989. In addition to the underground storage tanks, several secondary source areas were identified. Those included:

- An underground pipeline that connected the former solvent product tanks to the main facility;
- A former underground gasoline tank located just northeast of the Chemical Mixing Building;
- A former hazardous waste drum storage area (the Old Hazardous Waste Storage Area); located just east and south of the Chemical Mixing Building; and
- A former Chemical Mixing Building that was reportedly located in the area between monitoring wells MW-12 and MW-20.

Constituents of Concern (COCs) at the site include non-chlorinated and chlorinated solvents, the most prevalent of which are toluene, ethyl benzene, xylenes, TCE, PCE, and MC. A variety of other VOCs have been detected at the site in lesser concentrations.

1.3.2 Site Remedies Selected

The soils excavation conducted in July 2007 served as a source area removal action to help facilitate the groundwater remedy. The groundwater remedy selected for the site includes institutional controls and MNA.

1.3.3 Site Topography and Soils

The facility is situated approximately 1.4 miles west of the Mississippi River in an uplands area of the Mississippi River Valley. The topography of the uplands area generally consists of relatively narrow, flat to gently rolling hilltops, bordered by moderate to steep drainage side slopes. Ephemeral tributaries leading from the hilltop areas with moderately to steeply sloping sides are common. On the facility property, ground surface elevations range from approximately 660 feet above mean sea level (MSL) near Main Street to approximately 600 feet above MSL in the western portion of the property near Soap Creek. The majority of the facility buildings are at an approximate elevation of 640 feet above MSL.

The topographic high in the vicinity of the source areas is located, in general, in the area between the southwest side of the main facility building and the Chemical Mixing Building. This topographic high was artificially produced with fill material. This fill material, historically referred to as the "plant area fill," generally consisted of firm to stiff, medium plastic, silty clay with varying amounts of sand, gravel, brick, rubber, and debris. The plant area fill was thinnest near the main facility building and thickened towards the Employee Parking Lot. In the primary source area, the plant area fill was about eight to twelve feet thick. To the south and west of the Chemical Mixing Building, the plant area fill material rapidly sloped downward and ends near the edge of the Employee Parking Lot. Groundwater levels within the plant area fill historically ranged from four to ten feet below ground surface.

Plant area fill material was excavated during the source removal activities conducted in July 2007. The area that was excavated was located to the south and east of the Chemical Mix Building, generally along the embankment between monitoring wells MW-6A/6B, MW-2R, and MW-10A/10B. This area is shown on the report drawings (Appendix D). At the time of excavation, it was observed that groundwater appeared to be located in isolated layers or lenses of more permeable fill material that occurred within the reworked native soils. Based on the location of water encountered, odors, and staining, the COCs appeared to occur primarily in those layers or pockets of more permeable material, rather than distributed uniformly throughout the plant area fill.

The excavation was backfilled with gravel and capped with a clay soil cover on the side slope behind the retaining wall and concrete driveway on the upper portion by the Chemical Mix Building. Shallow groundwater from the fill material layers or lenses now seeps into the gravel fill zone behind the retaining wall.

A dewatering pump is installed in the excavation backfill. The pump is activated by a float sensor and removes water from the backfill on a periodic basis to keep the backfill dewatered. Removed water is treated through two 1,000-pound liquid phase granular activated carbon (GAC) units to remove VOCs in the water. The treated water is tested and discharged to the Keokuk Publically Owned Treatment Works (POTW). Samples are collected on a quarterly basis to monitor performance of the GAC system. Those results are reported to the EPA in quarterly progress reports.

A topographic low is located within the center of the Employee Parking Lot. This area was formerly a southeast-northwest trending natural drainage that was filled in. The fill material within the Employee Parking Lot area and the drainage is referred to as the "engineered fill". In the center of the drainage, the engineered fill appears to be seven to eight feet thick. The exact source of the engineered fill is not known although it appears to be reworked glacial till. The engineered fill generally consists of soft to firm, yellowish-brown to olive-brown (with some gray mottling), low plastic, silty clay with some sand and gravel. Groundwater levels in the engineered fill typically range from one to three feet below ground surface, indicating that the majority of engineered fill is saturated.

Underlying the plant area fill and engineered fill is glacial till consisting of oxidized, firm to stiff, yellowish-brown to light-brown (with gray mottling), medium to highly plastic clay. Occasional fractures and thin discontinuous sand zones have been observed in the till. At elevations below 591 to 598 MSL, the oxidized till starts to become unoxidized, becoming hard and dark gray with almost no fractures. Stiff brown native clay glacial till was observed beneath the plant area fill material during the July 2007 excavation activities.

Groundwater flow in the fill and glacial till at the facility is generally a subdued reflection of the topography. Groundwater flows from the topographic high near the Chemical Mixing Building and the main facility building in a southwesterly direction towards the former northwest-southeast trending drainage in the Employee Parking Lot then trends to the northwest towards the topographically lower area represented by the Cooling Pond. Historical groundwater elevations indicate that a consistent upward gradient is present in the MW-17 well cluster located near the pond.

Estimates of hydraulic conductivity based on slug tests performed in a number of wells screened in the oxidized glacial till ranged from 1.9×10^{-5} centimeters per second (cm/s) to 5.6×10^{-5}

cm/s with an average of 3.3×10^{-5} cm/s indicating that the glacial till yields little water. In addition to the slug tests, a simple, short-term pump test was performed in MW-10, which is screened in the oxidized glacial till from 19.4 feet to 29.4 feet below ground surface. The 4-inch diameter well was pumped dry in approximately 69 minutes after 34 gallons were removed at a pumping rate of 0.5 gallons per minute. Based on the pre-test water level, it was calculated that approximately 29.5 gallons were removed from the casing and filter pack while only 4.5 gallons were removed from the glacial till. The pump test results also confirmed that the glacial till yields little water. During historic groundwater monitoring events, drawdown of water levels at pumping rates of 0.05 gallons per minute (200 milliliters per minute [ml/min]) or less were commonly observed for the majority of the wells. These observations indicate that the discontinuous sand lenses and occasional fractures are not transmitting a large volume of water through the till and fill. The slug and pump test results, along with the observed drawdown of water levels at very low flow rates, indicate that the fill and glacial till are not capable of providing a sufficient volume of water to be used as a potable water source.

1.3.4 Previous Source Area Control Activities

In an effort to remove VOCs from source area soils in the vicinity of the Chemical Mixing Building, a soil vapor extraction (SVE) and vacuum groundwater recovery (VGR) system was installed and operated from February 25, 1999 to July 29, 2002. The SVE/VGR system was installed and operated as an interim measures action under the 1990 Consent Order. The system was located in the area around the east, north, and west sides of the Chemical Mixing Building. The VGR component of the system dewatered the fill in order to increase the thickness of the vadose zone available for treatment by the SVE component of the system. Through July 29, 2002, the SVE/VGR system removed 4,252 pounds of target VOC compounds and 12,851 pounds of total VOCs. The SVE/VGR operation was terminated in July 2002 after an evaluation of system removal rates indicated that the system had reached the limits of its effectiveness.

SECTION TWO**Groundwater Activities And Results****2.1 GROUNDWATER ELEVATIONS AND FLOW DIRECTIONS**

Groundwater levels were measured in the fill and glacial till monitoring wells on June 6, 2011. Contour maps for the shallow fill zones and the deeper till zone are shown in Drawings 1 and 2, respectively (Appendix D). Groundwater levels and elevations are presented in Table 1. Monitoring well and piezometer construction details are presented in Table 2.

Groundwater flow directions in both the fill and the glacial till in June 2011 remain consistent with those observed during past events. Both elevations and contour patterns have remained very consistent over the years.

Groundwater flow in both zones generally follows the topography with flow from the topographic high near the main facility building towards the topographic low in the center of the Employee Parking Lot. The topographic low is a former natural drainage, which was filled in during construction on the Employee Parking Lot. The northwest trending stormwater line marks the approximate location of the topographic low. Topographically higher areas to the south and west of the former drainage direct groundwater flow towards the topographic low in the Employee Parking Lot. Groundwater flows from the vicinity of the topographic low within the Employee Parking Lot downgradient towards the Cooling Pond.

Vertical gradients vary depending on location at the facility. Historically, there has been a downward gradient from the fill to the glacial till in the topographically higher area between the main facility building and the Chemical Mixing Building. In 2011, a downward gradient was observed in well cluster MW-6A/MW-6B.

In the Employee Parking Lot, vertical gradients were minor. Slight to moderate upward vertical gradients were observed at the MW-10, MW-13, MW-17, and MW-23 well clusters.

2.2 GROUNDWATER SAMPLING METHODS

The following monitoring wells were sampled during the 2011 annual event:

- Source area wells MW-1; MW-2R; MW-3; MW-6A, plus MW-7 located north of the Chemical Mix Building
- Primary plume wells MW-10; MW-10A; MW-13; MW-13A, MW-13B
- Downgradient and sentinel wells: MW-16; MW-17A; MW-17B; MW-23A; MW-23B
- Property line wells: MW-19; MW-20

Monitoring well purging and sampling was performed in general accordance with the United States Army Corps of Engineers (USACE) standard operating procedure (SOP) for low-flow groundwater sampling per the Corrective Measures Implementation Work Plan (URS, May 2006). The monitoring wells were purged using a submersible pump with inlets placed between the midpoint and bottom of the screened interval of the well. The monitoring wells were purged at rates ranging from approximately 50 to 300 ml/min.

Water quality parameters consisting of dissolved oxygen (DO), oxidation-reduction potential (ORP), temperature, conductivity, pH, and turbidity were measured approximately every five minutes. Groundwater samples were collected after the parameters and water levels stabilized.

SECTION TWO**Groundwater Activities And Results**

For wells in which parameters did not stabilize, sampling was performed following the low recovery sampling procedure in the USACE SOP. Sample collection field sheets are included in Appendix A.

The samples were placed in an ice-filled cooler after sample collection. The sample cooler was shipped to Accutest Laboratories, Inc. (Accutest) in Houston, Texas under standard chain-of-custody protocol, consistent with historic practices.

2.3 LABORATORY ANALYSIS AND DATA REVIEW ACTIVITIES

Groundwater samples were analyzed by Accutest for VOCs and natural attenuation indicator parameters. Analytes and analytical methods used include:

- VOCs – Method 8260B
- Dissolved Gases (Methane, Ethane, and Ethene) – Robert S. Kerr (RSK) 175
- Dissolved Iron and Manganese – Method 6010B
- Total Organic Carbon (TOC) – Method 9060
- Chloride and Sulfate – Method 300.0A
- Total Sulfide – Method 353.2
- Nitrate – Method 353.2
- Nitrite – Method 354.1
- Alkalinity – Method 310.1

The data were independently reviewed by a URS chemist and judged acceptable for use with some qualifiers as described below. The data review summary is included in Appendix B. VOC and geochemical data for the 2011 annual event is presented in Tables 3, 4, 5, and 6. Electronic copies of the laboratory reports are included on a CD located in Appendix D.

All laboratory data were validated for compliance with the established quality control (QC) criteria based on the QC results provided by the laboratory. The data validation was performed in accordance with the review criteria detailed in the Quality Assurance Project Plan (QAPP), using a process that generally follows that outlined in National Functional Guidelines for Laboratory Data Review, Organics and Inorganics (USEPA 2008, 2004). These guidelines provided the basis for determining whether data should be qualified. Following completion of the initial review, the data validation reports were reviewed by a senior chemist for concurrence.

Samples were analyzed to achieve the lowest possible reporting limits within the constraints of the method. In some cases, the samples were diluted due to elevated concentrations of analytes exceeding the calibration range of the instrument. For diluted samples, the reporting limits were adjusted relative to the dilution applied.

Trace level detections, reported between the method detection limit (MDL) and the laboratory reporting limit (RL), have been qualified as estimated (J).

SECTION TWO**Groundwater Activities And Results**

Overall, the sampling and analytical systems quality met criteria set forth in the QAPP. The data are considered usable without qualification with the exception of qualification due to equipment blank contamination.

Three equipment blank samples and five trip blank samples were collected during the sampling event to evaluate the potential for cross-contamination of the groundwater samples. One trip blank was contaminated with acetone, and two with MC. The samples collected and shipped in the same cooler as the trip blanks in question were below the RL for acetone and MC, therefore no data qualification was required. One equipment blank, EB-07-2011, was contaminated with toluene. The sample associated with this equipment blank, MW-7-2011, was below the RL for toluene, therefore no data qualification was required.

2.4 2010 ANNUAL GROUNDWATER MONITORING RESULTS

Monitoring results are presented in a number of fashions consistent with past reports. They include the following:

Complete monitoring results from June 2011 are presented by well in Tables 3, 4, 5, and 6. Laboratory data reports with results for each well are included on the CD contained in Appendix D.

VOC results for shallow and deep wells are listed on Drawing 3 and Drawing 4, respectively. Total VOC isoconcentration lines for 2011 compared to 2010 are presented in the following drawings:

- Drawing 5 – Total Non-Chlorinated VOCs, June 2011
- Drawing 6 – Total Non-Chlorinated VOCs, April 2010
- Drawing 7 – Total Chlorinated VOCs, June 2011
- Drawing 8 – Total Chlorinated VOCs, April 2010

Isoconcentration plume maps for individual constituents are presented in the following drawings:

- Drawing 9 - PCE isoconcentration map
- Drawing 10 - TCE isoconcentration map
- Drawing 11 - cis-1,2-DCE isoconcentration map
- Drawing 12 - Methylene chloride isoconcentration map
- Drawing 13 - Vinyl chloride isoconcentration map
- Drawing 14 - Total BTEX isoconcentration map

A cross section through the plume centerline wells is presented in Drawing 15 and MNA parameters are presented in Drawing 16.

Concentration trend analysis was performed on PCE, TCE, cis-1,2-Dichloroethene (DCE), MC, vinyl chloride (VC), and total BTEX in monitoring network wells using the Mann-Kendall method, in general accordance with the EPA guidance document, *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA/600/R-98/128).

SECTION TWO

Groundwater Activities And Results

Additionally, trend charts were prepared to visually depict concentration levels over time for the same constituents. The Mann-Kendall worksheets and trend charts are included in Appendix C.

The individual constituent plume boundaries were calculated utilizing the Concentration vs. Distance Attenuation Rate Constant method outlined in the EPA issue paper *Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies* (EPA/540/S-02/500). Those calculations are attached in Appendix E.

For discussion purposes, the monitoring wells have been divided into three groups based on their location as follows:

- Source area wells, plus MW-07 located north of the Chemical Mix Building;
- Primary plume wells, plus MW-13B in deep till and MW-16 outside centerline; and
- Sentinel and property line wells.

2.4.1 Source Area Wells

Source area wells include monitoring wells installed in fill materials in the vicinity of the former underground solvent product tanks and the Old Hazardous Waste Storage Area. The source area monitoring wells include the following:

- MW-1 (fill)
- MW-2R (fill)
- MW-3 (fill)
- MW-6A (fill)
- MW-7 (north of source area, till)

Well MW-2R is the replacement well for original well MW-2 that was removed during the 2007 excavation activities. For the purpose of trend analysis, MW-2R results were compared to historic results from MW-2.

Monitoring well MW-7, located north of the Chemical Mix Building is also included in this section, although it is not located in the immediate vicinity of the primary source area.

Prior to startup of the SVE system in February 1999, total VOC concentrations exceeded 200,000 micrograms/liter ($\mu\text{g/L}$) in monitoring wells MW-1 and MW-2, with lower, but still elevated VOC concentrations in MW-3 and MW-6A. However, after operation of the SVE/VGR system from February 1999 to July 2002, VOC concentrations dropped by orders of magnitude.

In June 2011, VOCs concentrations in source area wells MW-1, MW-2R, MW-3, and MW-6A remained orders of magnitude lower than historic levels and are generally consistent with 2010 results. Total chlorinated VOCs in MW-1 were $1.71 \mu\text{g/L}$ in 2011, as compared to $4.8 \mu\text{g/L}$ in 2010. Total non-chlorinated VOCs in MW-6A were $280 \mu\text{g/L}$ in 2011, as compared to $272 \mu\text{g/L}$ in 2010, and consisted totally of xylenes. It is believed that dewatering of the former excavation continues to draw residual VOCs from surrounding soils into the excavation zone and subsequent extraction by the pumping system.

SECTION TWO**Groundwater Activities And Results**

Monitoring well MW-7 is a till well located north of the Chemical Mix Building. No specific VOC source area was known to exist in the vicinity of MW-7, but in previous monitoring events a variety of VOCs had sporadically been detected in this well. Overall, VOC concentrations in this well are one to two orders of magnitude lower than those found in the primary plume (wells MW-10 and MW-13). Trend analyses (contained in Appendix C) suggest that PCE, TCE and cis-DCE concentrations in well MW-7 are showing an increasing trend while MC and BTEX concentrations are decreasing.

2.4.2 Primary Plume Wells

The primary plume wells include those monitoring wells that have been installed in the Employee Parking Lot below the embankment south and west of the Chemical Mixing Building. Some wells are installed in shallow fill material; others in the native glacial till. They include:

- MW-10A (primary plume, fill)
- MW-13A (primary plume, fill)
- MW-10 (primary plume, till)
- MW-13 (primary plume, till)
- MW-13B (beneath plume, deep till)
- MW-16 (outside primary plume, till)

Fill Wells

The primary plume fill wells include:

- MW-10A
- MW-13A

Wells MW-10A and MW-13A are shallow wells located in the Employee Parking Lot downgradient of the former underground solvent product tanks. Concentrations in the shallow zone remain orders of magnitude lower than those found in the deeper till zone (wells MW-10 and MW-13) and continue to show stable to decreasing concentration trends. Total VOC concentrations in MW-13A and MW-10A are shown in the table below.

Till Wells

The primary plume glacial till wells include

- MW-10
- MW-13

These wells are screened in the weathered glacial till zone located below the engineered fill material. Since April 2001, the highest VOC concentrations at the facility have been in MW-13 and MW-10. The highest VOC concentrations detected in these wells continues to be MC.

SECTION TWO**Groundwater Activities And Results**

TCE, PCE, and Cis-1,2-DCE concentrations are also elevated, but at concentrations an order of magnitude lower than MC.

Total VOC concentrations in wells MW-10 and MW-13 are several orders of magnitude higher than those reported in the overlying fill wells (MW-10A and MW-13A) and the deeper unoxidized unweathered till well MW-13B, as shown on the following table. Thus, the primary zone of remaining VOC contaminations remains limited to the upper weathered oxidized till.

**Total VOC Concentrations (µg/L)
Plume Centerline Wells**

	MW-10A	MW-10	MW-13A	MW-13	MW-13B
May 2007	322	13,054	14	13,623	6.25
May 2008	234	3,935	5	11,062	4.1
May 2009	32	8,300	4.6	3,967	ND
April 2010	14.52	4,589	3.5	5,002	0.67
June 2011	8.44	6,182	9.85	8,139	1.03

Total VOC concentrations in well MW-10 were higher in 2011 than in 2010, but lower than those reported in 2007 and 2009, as shown below. Trend analysis charts indicate stable to decreasing concentration trends in MW-10.

Total VOC concentrations in MW-13 were higher in 2011 than in 2009 and 2010, but still lower than in 2007 and 2008. Although VOC concentrations have increased over the past two years, the trend analysis charts still indicate a decreasing concentration trend. The results in both MW-10 and MW-13 are largely a function of the MC concentrations.

MW-13B is located adjacent to MW-13 and MW-13A and is screened in the deeper unoxidized unweathered till. Monitoring well MW-13B serves as a monitoring point in the deeper unweathered unoxidized till. In 2011, low level concentrations of TCE (0.7 µg/L) and PCE (0.33 µg/L) were detected in MW-13B.

Monitoring well MW-16 is a till well located downgradient of the MW-13 well cluster, on the opposite side of the low point and stormsewer line in the Employee Parking Lot. The VOC concentrations in MW-16 were below the RLs.

2.4.3 Sentinel and Property Line Wells

The sentinel wells include those monitoring wells that have been installed downgradient of the primary plume but upgradient of the Cooling Pond. Well clusters MW-17 and MW-23 serve as points to monitor for potential migration of VOCs towards the Cooling Pond. Each of the clusters has a monitoring well screened in the fill and underlying weathered glacial till.

SECTION TWO**Groundwater Activities And Results**

Fill Wells

The sentinel fill wells include:

- MW-17A
- MW-23A

Wells MW-17A and MW-23A are located in shallow fill material near the Cooling Pond and are directly downgradient of the primary plume located around MW-10 and MW-13. All VOC results were below the RLs in both wells. The statistical trend charts indicated increasing concentration trends for BTEX, but that is a function of the RL data being entered as the detection in the calculations.

Till Wells

The sentinel till wells include:

- MW-17B
- MW-23B

The VOC concentrations were below the RLs in wells MW-17B and MW-23B, located upgradient of the Cooling Pond.

Property Line Till Wells

The property line till wells include:

- MW-19
- MW-20

MW-19 and MW-20 serve as property line wells at the facility. Both wells are screened in the upper weathered till. MW-19 is located upgradient of the primary plume in a position to monitor the quality of groundwater flowing onto the site property at the Employee Parking Lot. Monitoring well MW-20 is located near the southwest corner of the facility building.

The VOC concentrations were below the RLs in MW-19 or MW-20. The statistical trend charts indicated increasing concentration trends for BTEX, but that is a function of the RL data being entered as the detection in the calculations.

2.5 NATURAL ATTENUATION EVALUATION

This section of the report describes the major natural attenuation processes, and the purpose of the MNA monitoring parameters. It repeats background information first presented in the 2007 report. Section 2.6 reviews the June 2011 monitoring results for MNA trends.

The VOCs present at highest concentrations in groundwater at the site are PCE, TCE, and MC, all of which are chlorinated VOCs. The primary natural attenuation process at work appears to be biodegradation of chlorinated VOCs through reductive dechlorination. Groundwater samples collected from each of the monitoring wells were analyzed for the following geochemical parameters:

SECTION TWO**Groundwater Activities And Results**

- Dissolved Gases (Methane, Ethane, and Ethene) – Robert S. Kerr (RSK) 175
- Dissolved Iron and Manganese – Method 6010B
- TOC – Method 9060
- Chloride and Sulfate – Method 300.0A
- Total Sulfide – Method 353.2
- Nitrate – Method 353.2
- Nitrite – Method 354.1
- Alkalinity – Method 310.1

In addition, DO and ORP were measured in the field at the time of sample collection. Data used for the natural attenuation evaluation are shown on Drawing 16.

2.5.1 Natural Attenuation Mechanisms

The EPA refers to “monitored” natural attenuation as:

“the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a timeframe that is reasonable compared to that offered by other more active methods. The “natural attenuation processes” that are at work include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentrations of contaminants in soil or groundwater. These in-situ processes include biodegradation, dispersion, dilution, sorption, volatilization, radioactive decay, and chemical or biological stabilization, transformation, or destruction of contaminants” (EPA, 1999).

Natural attenuation of VOCs in groundwater may result from one or more attenuation mechanisms that can be classified as either destructive or non-destructive. Typically, the destructive mechanisms are the most important processes since they result in the elimination of a contaminant. Biodegradation typically is the most important of the destructive mechanisms although abiotic mechanisms such as hydrolysis may play an important role for some contaminants. Non-destructive mechanisms include sorption, dispersion/dilution, and volatilization.

2.5.2 Biodegradation of Volatile Organic Constituents

Numerous studies have shown the effectiveness of biodegradation in the breakdown of non-chlorinated volatile organic constituents such as BTEX as well as chlorinated VOCs such as PCE, TCE, trichloroethane (TCA), and carbon tetrachloride. Biodegradation can occur through four different mechanisms: electron donor reactions, electron acceptor reactions, fermentation, and cometabolism. Each mechanism is described below.

Electron Donor Reactions

SECTION TWO**Groundwater Activities And Results**

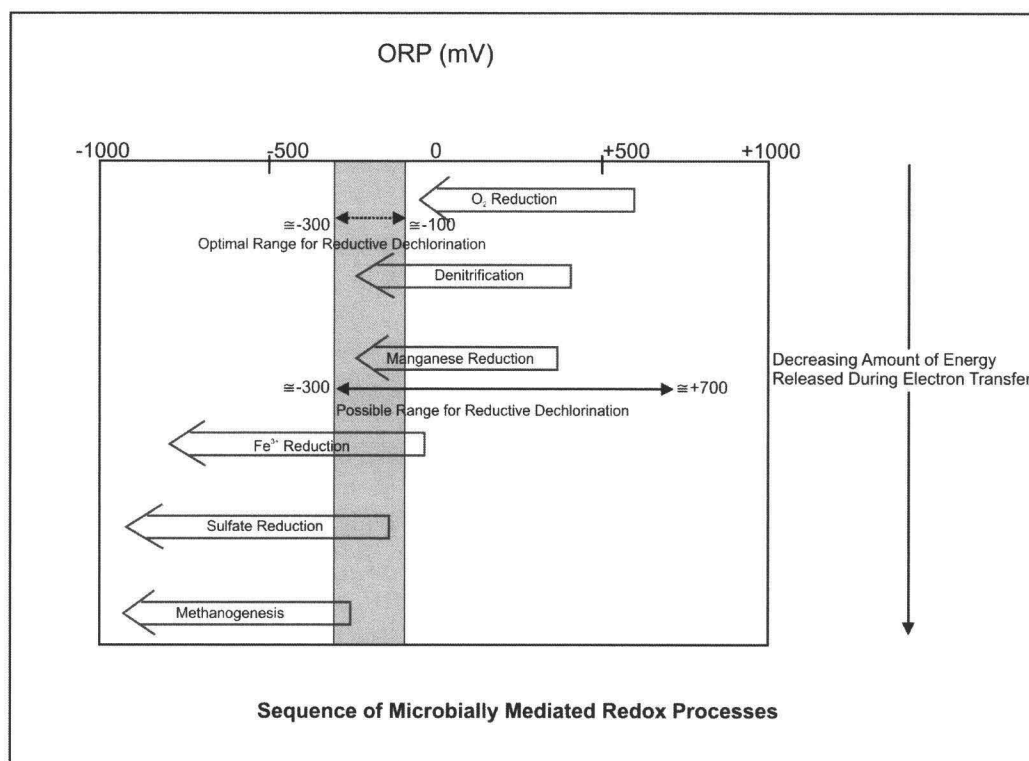
Microorganisms use the carbon within organic compounds as a food source. As the microorganisms break down the organic compounds to obtain the carbon, electrons are lost from the organic compounds (electron donors) and transferred to electron acceptors through oxidation-reduction reactions. The electron donors are oxidized and lose electrons while the electron acceptors are reduced and gain electrons. The release of energy provided through the electron transfer is used by the microorganisms to sustain metabolic processes and growth. Organic compounds including naturally occurring carbon, non-chlorinated VOCs such as BTEX, and some less highly chlorinated VOCs such as MC and VC can be used as electron donors. However, the more highly chlorinated VOCs such as PCE and TCE are generally believed to be incapable of serving as electron donors.

Electron Acceptor Reactions

To complete the oxidation-reduction reactions, the electrons removed from the electron donors must be transferred to electron acceptors. The most common electron acceptors are dissolved oxygen, nitrate, manganese (Mn^{4+}), ferric iron (Fe^{3+}), sulfate, and carbon dioxide. Under aerobic conditions, dissolved oxygen is used by aerobic microorganisms as an electron acceptor. After the available dissolved oxygen is depleted and the environment becomes anaerobic, microorganisms will sequentially use nitrate, manganese (Mn^{4+}), ferric iron (Fe^{3+}), sulfate, and carbon dioxide as electron acceptors. As the electron acceptors are exhausted, the ORP decreases and the groundwater environment becomes more reducing. Under certain reducing conditions, chlorinated VOCs may be used as electron acceptors by halorespiring microorganisms through a process called reductive dechlorination. During reductive dechlorination, a chlorine ion is removed from the VOC being reduced and is replaced with a free electron in the form of a hydrogen ion. Reductive dechlorination is the primary process through which most chlorinated VOCs are biodegraded. VOCs which may be biodegraded through their use as electron acceptors include common parent compounds such as PCE, TCE, TCA, and carbon tetrachloride as well as their breakdown products. The illustration presented below shows the typical ORP ranges where various electron acceptors are used and the possible and optimal ranges for reductive dechlorination,

SECTION TWO

Groundwater Activities And Results

**Fermentation**

Fermentation is a special type of oxidation-reduction reaction where the organic compound being degraded acts as both an electron acceptor and electron donor. Fermentation occurs in anaerobic environments and is typically a two step process. In the first step, organic compounds undergo fermentation to produce water, carbon dioxide, volatile fatty acids such as acetate, and most importantly, dissolved hydrogen. The carbon dioxide, dissolved hydrogen, and volatile fatty acids may then be used in the second fermentation step by methanogenic microorganisms to produce methane. Dissolved hydrogen produced by the first fermentation step may also be used by halo-respiring microorganisms (the reductive dechlorinators) to degrade chlorinated VOCs. The presence of methane indicates a deeply reducing environment with dissolved hydrogen present that is favorable for breakdown of chlorinated VOCs through reductive dechlorination. Naturally occurring organic carbon, non-chlorinated VOCs such as BTEX, and some chlorinated VOCs such as MC can undergo fermentation to produce the dissolved hydrogen necessary for reductive dechlorination.

Cometabolism

Under cometabolism, chlorinated VOCs such as TCE may be indirectly degraded by enzymes fortuitously produced by microorganisms as they use non-chlorinated VOCs such as BTEX to meet their food and energy requirements. The microorganisms receive no direct benefit from the breakdown of the chlorinated VOCs. Cometabolic reactions are typically slow and are not usually a significant element in the biodegradation of VOCs.

SECTION TWO**Groundwater Activities And Results****2.5.3 Behavior of VOC Plumes**

Non-chlorinated and chlorinated VOC plumes may exhibit different behavior dependent on their specific environment. In general, non-chlorinated VOCs such as BTEX can be degraded by both aerobic and anaerobic microorganisms for which they act as a carbon source and electron donor. In most environments, there is generally a sufficient amount of electron acceptors present to complete the oxidation-reduction reactions necessary for effective biodegradation of non-chlorinated VOCs. This typically allows the non-chlorinated VOC plumes to stabilize or even decrease in size after relatively short periods of time. Conversely, with the exception of a few of the less chlorinated VOCs like MC and VC which can act as electron donors, most chlorinated VOCs undergoing biodegradation generally serve as electron acceptors. For most chlorinated VOCs to be effectively degraded there must be a sufficient source of electron donors being biodegraded to drive the groundwater environment to sufficiently reducing conditions. At many sites, the amount of electron donors present is not sufficient to promote complete degradation of the chlorinated VOCs. Thus, depending on the amount of electron donors and the type of chlorinated VOCs present, the behavior of chlorinated VOC plumes may exhibit three general types of behavior. The types of plume behavior are described below.

Type 1 Behavior

Type 1 Behavior occurs when the water-bearing unit has an electron donor consisting of anthropogenic (man-made) carbon such as BTEX which drives reductive dechlorination. This type of behavior can result in the rapid degradation of highly oxidized chlorinated VOCs like PCE and TCE. However, degradation rates decrease sequentially for the less oxidized chlorinated VOCs (i.e. VC degrades slower than 1,2-DCE, which degrades slower than TCE, etc.) This may result in the accumulation of breakdown products.

Type 2 Behavior

Type 2 behavior occurs when the water bearing unit has relatively high concentrations of naturally occurring organic carbon. The natural organic carbon serves as the electron donor which drives reductive dechlorination. Type 2 behavior reportedly results in slower degradation of the more chlorinated VOCs such as PCE and TCE, but under the right conditions, breakdown of these compounds may still occur rapidly.

Type 3 Behavior

Type 3 behavior occurs when the water bearing unit has low concentrations of native and/or anthropogenic carbon and has DO concentrations of greater than 1 milligram per liter (mg/L). Under these aerobic conditions, reductive dechlorination typically cannot occur. However, some biodegradation may occur through the oxidation of VC by aerobic microorganisms. Advection, dispersion/dilution, and sorption may play a more significant role in the natural attenuation of chlorinated VOCs in this environment.

SECTION TWO**Groundwater Activities And Results****Mixed Behavior**

A single chlorinated VOC plume may exhibit some or all three types of behavior in different parts of a plume. For example, within the source area, Type 1 or Type 2 behavior may be occurring to promote degradation of the more chlorinated VOCs like PCE and TCE while downgradient Type 3 behavior may be occurring in which VC is being oxidized. This is the preferred scenario since the oxidation of VC to carbon dioxide occurs rapidly in the downgradient aerobic portion of the plume preventing accumulation of VC.

2.5.4 Evidence Required to Demonstrate Natural Attenuation

As stated in the Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater (EPA, 1998), three lines of evidence may be used to evaluate whether natural attenuation is occurring. These lines of evidence include:

First Line of Evidence – Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentrations over time at appropriate monitoring or sampling points

Second Line of Evidence – Hydrogeologic and geochemical data that can be used to demonstrate indirectly the type(s) of natural attenuation processes active at the site, and the rate at which such processes will reduce contaminant concentrations to required levels

Third Line of Evidence – Data from field or microcosm studies (conducted in or with actual contaminated site media) which directly demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern (typically used to demonstrate biological degradation processes only)

The first and second lines of evidence are typically required to be proven in order to support a natural attenuation evaluation. Where the data are inadequate or inconclusive, the information supporting the third line of evidence may be required.

2.6 SITE-SPECIFIC NATURAL ATTENUATION EVALUATION

The source removal action was completed in July 2007. The June 2011 sampling was the fourth annual monitoring event following that removal. The primary plume extends from the source area through the MW-10 and MW-13 well clusters in the center of the plume, to the downgradient sentinel well clusters MW-17 and MW-23.

2.6.1 Plume Dimensions and Contaminant Mass/Concentration Trends

Drawings 5, 6, 7, and 8 present isoconcentration maps for total chlorinated and total non-chlorinated VOCs in the primary plume for June 2011 compared to April 2010. These drawings present overall dimensions of the plume in the shallow fill material zone and the upper till zone. The 2007 groundwater monitoring report included similar drawings for the years 2004, 2001, and 1991, which previously showed that the plume had been reduced at that point in time from original dimensions mapped in 1991.

A statistical method, known as the Mann-Kendall Test is used each year to evaluate plume stability based on concentration trends for individual constituents in individual wells. Those results were presented in Section 2.4, and the worksheets are contained in Appendix C.

SECTION TWO**Groundwater Activities And Results**

Graphical concentration vs. time charts for the primary VOCs in each well are also included in Appendix C.

Mapping the plume extent for individual constituents was begun in 2007. Similar drawings were prepared again from the June 2011 data (Drawings 9 to 14). The plume boundaries were calculated utilizing the Concentration vs. Distance Attenuation Rate Constant method outlined in the EPA issue paper *Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies* (EPA/540/S-02/500).

The June 2011 monitoring results are generally consistent with the April 2010 concentrations. The results also suggest that the VOC concentrations in the center of the plume and plume boundaries have decreased overall since 2007. The results in well MW-10A (the first well downgradient from the excavation area) decreased markedly after the 2007 source removal.

2.6.2 Geochemical Indicators of Natural Attenuation

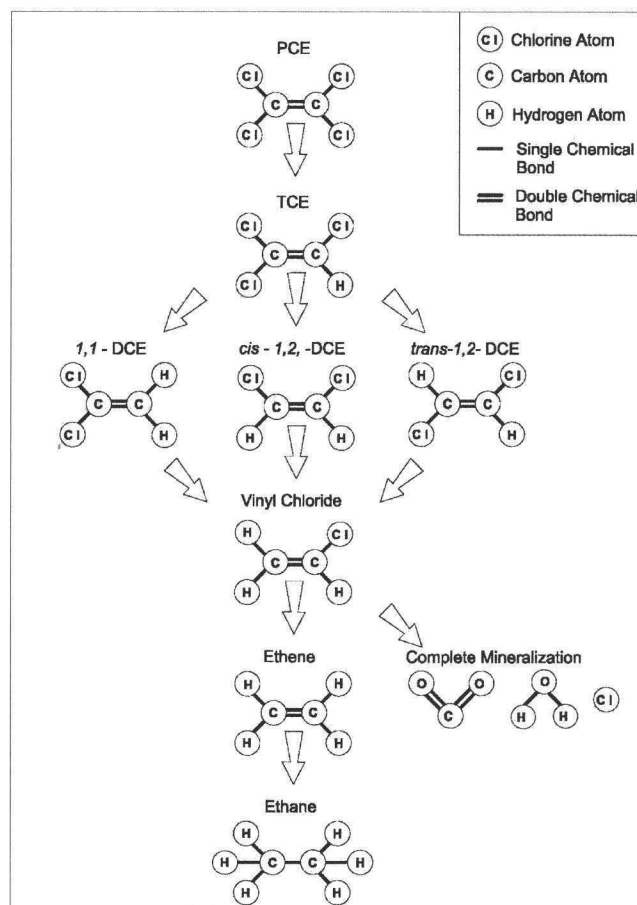
The most significant indicators of natural attenuation at this site are the long term decreases in primary contaminant concentrations coupled with the presence of degradation daughter compounds. In addition, a zone of anoxic and reducing conditions is present within the center of the plume. Since most of the BTEX compounds have been reduced due to the processes related to the natural degradation of the chlorinated VOCs, the primary organic carbon source that may support continuing reductive dechlorination appears to be MC.

Parent Compounds and Degradation Products

The primary non-chlorinated VOCs historically detected in groundwater at the Facility have been toluene, ethyl benzene, and xylenes. At most sites, non-chlorinated VOCs undergoing biodegradation are oxidized directly to carbon dioxide and water. These compounds were found in water removed from or the excavation backfill zone by the dewatering system, but concentrations decline significantly in the shallow and deeper monitoring wells immediately downgradient of that zone.

The primary chlorinated VOC parent compounds detected in groundwater at the site are MC, PCE, and TCE. PCE is the most chlorinated of the compounds. As PCE degrades through reductive dechlorination it is transformed into TCE. Through further reductive dechlorination, TCE is degraded to DCE then to VC, and finally to ethene and ethane. Of the three DCE isomers (1,1-DCE, cis-1,2-DCE, and trans-1,2-DCE), reductive dechlorination produces greater concentrations of cis-1,2-DCE than of the other two isomers. In addition, the presence of VC also indicates that reductive dechlorination is occurring.

VC is typically not present as a primary contaminant since it is not used as a solvent and it exists as a gas at room temperature. For these reasons, the presence of cis-1,2-DCE and VC are strong indicators of the occurrence of reductive dechlorination. The sequential degradation of the chlorinated ethenes is illustrated below.



Reductive dechlorination of chlorinated ethenes (From EPA/600/R-98/128)

In June 2011, cis-1,2-DCE remains present in wells MW-10 and MW-13, and VC remains present in MW-13, providing evidence of degradation products.

Presence and Distribution of Electron Donors

Biodegradation of non-chlorinated VOCs is dependent upon a sufficient supply of electron acceptors (e.g., DO, ferric iron, manganese, nitrate, and sulfate) for which there is generally a sufficient supply at most sites. Conversely, chlorinated VOCs are dependent upon electron donors (naturally occurring and anthropogenic carbon sources) to drive the environment to sufficiently reducing conditions favorable for reductive dechlorination.

BTEX is considered the primary carbon source and electron donor at many sites where these compounds are present in sufficient concentrations. According to EPA's method for preliminary screening for reductive dechlorination (EPA, 1998), BTEX concentrations exceeding 100 µg/l are sufficient to support reductive dechlorination although it may also occur at lower concentrations. Total xylene concentrations in shallow well MW-6A near the former excavation were 280 µg/L. This provides a carbon source to support reductive dechlorination in the source zone, but concentrations appear insufficient in the MW-10 and MW-13 well clusters to provide the required carbon source.

SECTION TWO**Groundwater Activities And Results**

TOC is another general indicator of the amount of electron donors available. According to EPA's method for preliminary screening for reductive dechlorination, TOC concentrations greater than 20 mg/L generally indicate that there is a sufficient mass of electron donors to support reductive dechlorination although it may occur at lower concentrations. In June 2011, only MW-13A and MW-23A had TOC concentrations above that level.

Elevated concentrations of MC are present in wells MW-10 and MW-13, and it has the potential to serve as the primary electron donor after the consumption of the non-chlorinated compounds.

Presence of Electron Acceptors and Metabolic Byproducts

In addition to the electron donors, electron acceptors are required to complete microbially mediated oxidation-reduction reactions. Evaluation of the presence or absence and relative concentrations of the electron acceptors, as well as metabolic byproducts, provide indications of the types of microbially mediated reactions occurring. Groundwater in the zone extending from the 2007 excavation area to the MW-13 well cluster exhibits some reducing indicators such as low DO, negative ORP, the presence of ethene, ethane, and methane, or elevated concentrations of ferrous iron or manganese. Multiple indicators are found near the MW-13 well cluster.

DO is the first electron acceptor to be consumed, and anaerobic conditions are required to support reductive dechlorination (generally less than 0.5 mg/L is required). Reductive dechlorination may occur under a wide range of ORP ranging from approximately +700 to -300 milli-volts (mV). However, reductive dechlorination typically occurs at ORP values of less than +50 mV with concentrations less than -100 mV indicating that reductive dechlorination is likely.

DO and/or ORP results that could support reducing conditions were reported in wells MW-10A, MW-10, MW-13A, and MW-13 in the center of the plume, fill zone well MW-6A, parking lot well MW-16 located just downgradient of the plume, and downgradient wells MW-17B and MW-23A. Of these wells only MW-17B had DO readings of less than 0.5 mg/L and only wells MW-10 and MW-23A had ORP readings of less than -100 mV.

After the available DO is depleted, nitrate may be used as an electron acceptor for the anaerobic biodegradation of chlorinated VOCs through the process of denitrification. Therefore, where denitrification is or has been occurring, nitrate concentrations tend to be lower than background concentrations. Consistent with previous results, nitrate levels remain generally low throughout the site and therefore evidence for denitrification is inconclusive.

Drawing 16 presents the MNA parameter results, and illustrates zones of the site that support reductive dechlorination. The reducing zones are based primarily on the presence of degradation products evaluated along with DO levels and redox conditions.

Following depletion of nitrate, manganese can be used as an electron acceptor to degrade non-chlorinated VOCs. In this process, manganese is reduced from Mn^{4+} to Mn^{2+} . Mn^{2+} is a dissolved form of manganese, and when present at concentrations greater than background levels, is indicative that microorganisms are using manganese as an electron acceptor.

Dissolved manganese levels in the center of the plume range from approximately 2 to 9 mg/l in the MW-10 and MW-13 well clusters, compared to less than 1 mg/l in perimeter wells MW-20 and MW-19. This is also consistent with the 2007, 2008, 2009 and 2010 results.

SECTION TWO

Groundwater Activities And Results

The next electron acceptor to be used following the depletion of nitrate and manganese (Mn^{4+}) is ferric iron (Fe^{3+}). When used as an electron acceptor, Fe^{3+} is reduced to form ferrous iron (Fe^{2+}) which occurs in dissolved form. Therefore, locations where high levels of dissolved iron are present can be indicative of an iron-reducing environment. Dissolved iron levels in the shallow plume centerline wells MW-10A and MW-13A were 25 mg/L and 78.7 mg/L, compared to non-detect and 0.362 mg/L in perimeter wells MW-19 and MW-20.

Sulfate normally becomes the preferred electron acceptor after ferric iron is consumed. Under sulfate reducing conditions, sulfate is converted to sulfide. Therefore, sulfate concentrations may be expected to be lower where sulfate reducing conditions exist compared to background conditions. Sulfate and sulfide results at the site have not historically exhibited clear trends.

Methanogenic bacteria use dissolved hydrogen as an electron donor and carbon dioxide as an electron acceptor to meet metabolic requirements which results in the production of methane. The presence of methane indicates a deeply reducing environment with dissolved hydrogen present that is favorable for the reductive dechlorination of chlorinated VOCs. Consistent with past results, methane concentrations are elevated in the shallow zone of the center of the plume (MW-6A, MW-10A, MW-13A, and MW-23A) relative to perimeter wells.

According to EPA's method for preliminary screening for reductive dechlorination (EPA, 1998), ethene concentrations exceeding 10 $\mu\text{g/l}$ indicate that VC is degrading to ethene through reductive dechlorination. According to EPA, 1998, ethane concentrations exceeding 100 $\mu\text{g/l}$ indicates that ethene is being further reduced to ethane. Ethene and ethane levels were inconclusive in 2011.

During reductive dechlorination, chloride ions are removed from the chlorinated VOCs and replaced with hydrogen ions. Thus, concentrations of chloride exceeding background levels are expected in areas where reductive dechlorination is actively degrading chlorinated VOCs. Chloride results were inconsistent across the site in 2007 and potentially showed some indications of dechlorination in 2008. As in 2009 and 2010, 2011 concentrations were elevated in wells MW-6A, MW-13A, MW-16, and MW-23A relative to background wells MW-19 and MW-20.

MNA Summary

Natural attenuation parameters are presented on Drawing 16. The drawing also depicts zones within the plume exhibiting conditions that are conducive for reductive dechlorination. Overall, the reducing zone may be smaller than the previous year, but the middle of the plume in the vicinity of the MW-10 and MW-13 well clusters continues to exhibit the necessary reducing conditions.

2.7 REFERENCES

- URS Corporation. 2007 Annual Groundwater Monitoring Report, Former Sheller-Globe Facility, 3200 Main Street, Keokuk, Iowa, Revision 1. October 2007
- U.S. Environmental Protection Agency. Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies (EPA/540/S-02/500).
- U.S. Environmental Protection Agency. 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water. September 1998.

SECTION TWO

Summary of 2011 Groundwater Activities And Results

U.S. Environmental Protection Agency. 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. Interim Final OSWER Directive 9200.4.17.

The general conclusions based on the results of the 2011 annual groundwater monitoring event are:

- The primary VOC plume located in the Employee Parking Lot in the vicinity of the MW-10 and MW-13 well clusters remains stable.
- VOC concentrations in sentinel well clusters (MW-17 and MW-23) and property line wells (MW-19 and MW-20) remain below MCLs.
- Groundwater flow directions continue to remain consistent with historic patterns. Topographic and hydrogeologic conditions limit off-site migration of the VOC plume in the area of wells MW-10 and MW-13. The plume remains contained on-site.
- The primary VOCs in the parking lot plume continue to be MC, TCE, and PCE. BTEX constituents in that area have been largely reduced due to the processes related to the natural degradation of the chlorinated VOCs.
- The most significant indicators of natural attenuation at this site continue to be the presence of degradation daughter compounds. Zones of anoxic and reducing conditions which are necessary for reductive dechlorination to take place are slightly smaller than in previous years but remain present in the vicinity of the MW-10 and MW-13 well clusters.
- Since most of the BTEX compounds have been exhausted as part of the natural degradation of the chlorinated VOCs, the primary organic carbon source remaining that may continue to support reductive dechlorination appears to be MC. As a result, degradation rates may be slower in the future, but the chlorinated VOC plume continues to be stable and contained on-site.
- The next annual sampling event is scheduled to be conducted in the spring of 2012. That will represent the fifth sampling event conducted subsequent to the source removal activities, and a five year review will be required after that event.

Table 1
June 6, 2011 Water Levels and Groundwater Elevations

Well I.D.	Top of Casing Elevation (Feet above MSL)	June 6, 2011	
		Depth to Groundwater (Feet below top of PVC Casing)	Elevation of Groundwater (Feet above MSL)
MW-1	641.22	5.35	635.87
MW-2R ⁽¹⁾	640.45	8.31	632.14
MW-3	639.22	11.71	627.51
MW-5	640.97	4.83	636.14
MW-6A	641.37	3.75	637.62
MW-6B	641.22	6.47	634.75
MW-7	638.54	9.95	628.59
MW-8	641.96	3.95	638.01
MW-9	639.07	13.65	625.42
MW-10	624.22	0.89	623.33
MW-10A	624.38	2.20	622.18
MW-11	627.24	NM	NM
MW-11R	627.43	4.22	623.21
MW-12	643.71	5.77	637.94
MW-13	623.56	1.86	621.70
MW-13A	623.30	1.75	621.55
MW-13B	623.46	1.98	621.48
MW-14 ⁽²⁾	628.55	NM	NM
MW-15	629.62	1.45	628.17
MW-16	623.55	3.33	620.22
MW-17A	620.64	1.90	618.74
MW-17B ⁽³⁾	620.93	0.00	620.93
MW-18	624.79	2.52	622.27
MW-19	624.15	2.01	622.14
MW-20	644.41	7.45	636.96
MW-21 ⁽²⁾	647.59	NM	NM
MW-23A	621.59	3.18	618.41
MW-23B	621.42	2.29	619.13
IW-6 (Excavation backfill zone) ⁽⁴⁾	631.67	NM	NM

(1) Well MW-2 replaced October 2007. Elevation surveyed relative to MW-1 top of casing.

(2) Wells MW-14 and MW-21 not found

(3) Groundwater in MW-17B stands above ground surface. The water level was measured above the TOC using a 3.02 ft long riser extension. Water level was measured from the riser extension.

(4) Well IW-6 is a pumping well installed within the excavation backfill during the July 2007 source removal activities. The TOC was surveyed relative to well MW-1. Due to pumping equipment in the well, water levels were not collected.

TABLE 2
MONITORING WELL AND PIEZOMETER CONSTRUCTION DETAILS

Well I.D.	Date Installed	Elevation of Top of PVC Casing (Feet above MSL)	Elevation of Ground Surface (Feet above MSL)	Total Depth of Boring (Feet)	Borehole Diameter (Inches)	Casing Diameter/ Material (Inches)	Elevation of Top of Screen (Feet above MSL)	Elevation of Bottom of Screen (Feet above MSL)	Geologic Material in Screened Interval
MW-1	Oct-89	641.22	641.59	16.00	NA	4/PVC	636.59	626.59	Fill
MW-2R ⁽¹⁾	Oct-07	640.45	640.97	16.00	8.30	2/PVC	635.45	630.45	Fill
MW-3	Oct-89	639.22	639.56	16.00	NA	4/PVC	634.53	624.53	Fill
MW-5	Nov-90	640.97	641.34	31.50	10.00	4/PVC	610.73	610.70	Weathered Till
MW-6A	Nov-90	641.37	641.65	16.00 ⁽³⁾	8.00	2/PVC	637.20	627.20	Fill
MW-6B	Nov-90	641.22	641.59	32.50	8.00	2/PVC	619.14	609.14	Weathered Till
MW-7	Nov-90	638.54	638.95	41.00	8.00	2/PVC	608.53	598.70	Weathered Till
MW-8	Nov-90	641.96	642.22	31.50	8.00	2/PVC	621.85	611.85	Weathered Till
MW-9	May-91	639.07	639.38	35.00	8.00	2/PVC	615.05	605.05	Weathered Till
MW-10	May-91	624.22	624.46	30.00	9.00	4/PVC	605.04	595.04	Weathered Till
MW-10A	Nov-98	624.38	624.83	8.00	8.00	2/PVC	619.53	617.23	Fill
MW-11 ⁽²⁾	May-91	627.24	627.49	35.00	8.00	2/PVC	603.07	593.07	Weathered Till
MW-11R	Nov-98	627.43	627.82	35.00	8.00	2/PVC	603.32	593.32	Weathered Till
MW-12	May-91	643.71	643.92	35.00	8.00	2/PVC	619.49	609.49	Weathered Till
MW-13	Nov-91	623.56	623.92	29.00	8.00	2/PVC	606.43	596.43	Weathered Till
MW-13A	Oct-92	623.30	623.71	11.00	7.88	2/PVC	618.48	613.48	Fill
									Unweathered Glacial
MW-13B	Oct-92	623.46	624.12	53.00	7.88	2/PVC	583.59	573.59	Till
MW-14	Nov-91	628.55	629.22	34.00	8.00	2/PVC	606.82	596.82	Weathered Till
MW-15	Nov-91	629.62	630.08	34.00	8.00	2/PVC	607.63	597.63	Weathered Till
MW-16	Oct-92	623.55	624.10	36.00	7.88	2/PVC	598.93	588.93	Weathered Till
MW-17A	Oct-92	620.64	620.92	11.00	7.88	2/PVC	615.72	610.72	Fill
MW-17B	Oct-92	620.93	621.07	35.00	7.88	2/PVC	597.37	587.37	Weathered Till
MW-18	Oct-92	624.79	625.38	36.00	7.88	2/PVC	600.38	590.38	Weathered Till
MW-19	Feb-95	624.15	624.91	29.00	7.25	2/PVC	606.15	596.75	Weathered Till
MW-20	Feb-95	644.41	644.55	39.00	7.25	2/PVC	616.45	606.95	Weathered Till
MW-21	Feb-95	647.59	647.79	54.00	7.25	2/PVC	603.79	594.29	Weathered Till
MW-23A	Nov-98	621.59	621.91	9.50	8.00	2/PVC	616.91	614.11	Fill
MW-23B	Nov-98	621.42	622.01	34.30	8.00	2/PVC	598.81	588.81	Weathered Till
P-1	May-98	644.71	644.96	23.58	2.13	0.5/PVC	630.38	621.38	Weathered Till
P-2	May-98	644.62	644.86	21.96	2.13	0.5/PVC	631.90	622.90	Weathered Till
P-3	May-98	641.73	641.96	17.58	2.13	0.5/PVC	633.38	624.38	Weathered Till
P-4	May-98	644.47	644.69	22.25	2.13	0.5/PVC	631.44	622.44	Weathered Till
P-5	May-98	648.84	649.05	20.92	2.13	0.5/PVC	637.13	628.13	Weathered Till
P-6	Nov-98	640.89	641.23	10.00	8.00	0.5/PVC	636.23	631.53	Weathered Till
P-7	Nov-98	624.31	624.67	10.00	8.00	0.5/PVC	619.67	616.87	Fill
P-8	Nov-98	627.64	628.12	35.00	8.00	0.5/PVC	603.62	593.92	Weathered Till
IW-6 ⁽³⁾	Jul-07	631.67	631.89	~ 10	NA	4/PVC	624	622	Gravel Backfill

Notes:

1. Wells MW-2, MW-4, and MW-22 were abandoned in June 2007. MW-2 was replaced with MW-2R in October 2007.
2. MW-11 abandoned in Nov-98 and replaced with MW-11R
3. IW-6 is currently a pumping well. The well was installed in the excavation backfill during the July 2007 source removal.

TABLE 3
ANALYTICAL RESULTS FOR EQUIPMENT AND TRIP BLANKS
2011 ANNUAL GROUNDWATER SAMPLING EVENT
3200 MAIN STREET, KEOKUK, IOWA

	EB-07-2011			EB-13B-2011			EB-23B-2011			TRIP BLANK			TRIP BLANK			TRIP BLANK			TRIP BLANK 1			TRIP BLANK 2			TRIP BLANK 3			TRIP BLANK 4		
	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit
Volatiles (UG/L)																														
1,1,1-Trichloroethane		U	0.62		U	0.31		U	0.62		U	0.62		U	0.62		U	0.31		U	0.62		U	0.62		U	0.62		U	0.62
1,1,2,2-Tetrachloroethane		U	1.2		U	0.38		U	1.2		U	1.2		U	0.38		U	1.2		U	1.2		U	1.2		U	1.2		U	1.2
1,1,2-Trichloroethane		U	0.98		U	0.36		U	0.98		U	0.98		U	0.98		U	0.36		U	0.98		U	0.98		U	0.98		U	0.98
1,1-Dichloroethane		U	0.52		U	0.29		U	0.52		U	0.52		U	0.52		U	0.29		U	0.52		U	0.52		U	0.52		U	0.52
1,1-Dichloroethylene		U	0.5		U	0.4		U	0.5		U	0.5		U	0.5		U	0.4		U	0.5		U	0.5		U	0.5		U	0.5
1,2-Dichloroethane		U	0.62		U	0.2		U	0.62		U	0.62		U	0.62		U	0.2		U	0.62		U	0.62		U	0.62		U	0.62
1,2-Dichloroethene		U	1		U	0.54		U	1		U	1		U	1		U	0.54		U	1		U	1		U	1		U	1
1,2-Dichloropropane		U	0.62		U	0.25		U	0.62		U	0.62		U	0.62		U	0.25		U	0.62		U	0.62		U	0.62		U	0.62
2-Butanone (MEK)		U	3.9		U	1.8		U	3.9		U	3.9		U	3.9		U	1.8		U	3.9		U	3.9		U	3.9		U	3.9
2-Hexanone		U	3.2		U	2.4		U	3.2		U	3.2		U	3.2		U	2.4		U	3.2		U	3.2		U	3.2		U	3.2
4-Methyl-2-pentanone (MIBK)		U	9.9		U	1.9		U	9.9		U	9.9		U	9.9		U	1.9		U	9.9		U	9.9		U	9.9		U	9.9
Acetone		U	4.7		U	10		U	4.7		U	4.7		U	4.7	12	J	10		U	4.7		U	4.7		U	4.7		U	4.7
Benzene		U	0.5		U	0.25		U	0.5		U	0.5		U	0.5		U	0.25		U	0.5		U	0.5		U	0.5		U	0.5
Bromodichloromethane		U	0.49		U	0.25		U	0.49		U	0.49		U	0.49		U	0.25		U	0.49		U	0.49		U	0.49		U	0.49
Bromoform		U	1.4		U	0.35		U	1.4		U	1.4		U	1.4		U	0.35		U	1.4		U	1.4		U	1.4		U	1.4
Carbon disulfide		U	0.53		U	0.36		U	0.53		U	0.53		U	0.53		U	0.36		U	0.53		U	0.53		U	0.53		U	0.53
Carbon tetrachloride		U	0.66		U	0.36		U	0.66		U	0.66		U	0.66		U	0.36		U	0.66		U	0.66		U	0.66		U	0.66
Chlorobenzene		U	0.56		U	0.22		U	0.56		U	0.56		U	0.56		U	0.22		U	0.56		U	0.56		U	0.56		U	0.56
Chloroethane		U	0.92		U	0.44		U	0.92		U	0.92		U	0.92		U	0.44		U	0.92		U	0.92		U	0.92		U	0.92
Chloroform		U	0.64		U	0.2		U	0.64		U	0.64		U	0.64		U	0.2		U	0.64		U	0.64		U	0.64		U	0.64
cis-1,2-Dichloroethene		U	0.56		U	0.24		U	0.56		U	0.56		U	0.56		U	0.24		U	0.56		U	0.56		U	0.56		U	0.56
cis-1,3-Dichloropropene		U	0.48		U	0.2		U	0.48		U	0.48		U	0.48		U	0.2		U	0.48		U	0.48		U	0.48		U	0.48
Dibromochloromethane		U	0.61		U	0.29		U	0.61		U	0.61		U	0.61		U	0.29		U	0.61		U	0.61		U	0.61		U	0.61
Ethylbenzene		U	0.55		U	0.25		U	0.55		U	0.55		U	0.55		U	0.25		U	0.55		U	0.55		U	0.55		U	0.55
Hexane		U	1.3		U	0.66		U	1.3		U	1.3		U	1.3		U	0.66		U	1.3		U	1.3		U	1.3		U	1.3
Isobutyl alcohol		U	5.4		U	23		U	5.4		U	5.4		U	5.4		U	23		U	5.4		U	5.4		U	5.4		U	5.4
Methyl bromide (Bromomethane)		U	0.94		U	0.31		U	0.94		U	0.94		U	0.94		U	0.31		U	0.94		U	0.94		U	0.94		U	0.94
Methyl chloride (Chloromethane)		U	0.84		U	0.27		U	0.84		U	0.84		U	0.84		U	0.27		U	0.84		U	0.84		U	0.84		U	0.84
Methylene chloride		U	0.41		U	1		U	0.41	0.51	J	0.41	0.55	J	0.41		U	1		U	0.41		U	0.41		U	0.41		U	0.41
n-Butanol		U	12		U	33		U	12		U	12		U	12		U	33		U	12		U	12		U	12		U	12
Styrene		U	0.56		U	0.22		U	0.56		U	0.56		U	0.56		U	0.22		U	0.56		U	0.56		U	0.56		U	0.56
tert-Butyl methyl ether		U	0.73		U	0.28		U	0.73		U	0.73		U	0.73		U	0.28		U	0.73		U	0.73		U	0.73		U	0.73
Tetrachloroethylene		U	0.91		U	0.33		U	0.91		U	0.91		U	0.91		U	0.33		U	0.91		U	0.91		U	0.91		U	0.91
Toluene	0.51	J	0.43		U	0.26		U	0.43		U	0.43		U	0.43		U	0.26		U	0.43		U	0.43		U	0.43		U	0.43
trans-1,2-Dichloroethylene		U	0.45		U	0.3		U	0.45		U	0.45		U	0.45		U	0.3		U	0.45		U	0.45		U	0.45		U	0.45
trans-1,3-Dichloropropene		U	0.68		U	0.21		U	0.68		U	0.68		U	0.68		U	0.21		U	0.68		U	0.68		U	0.68		U	0.68
Trichloroethene (TCE)		U	0.52		U	0.36		U	0.52		U	0.52		U	0.52		U	0.36		U	0.52		U	0.52		U	0.52		U	0.52
Vinyl chloride		U	1		U	0.4		U	1		U	1		U	1		U	0.4		U	1		U	1		U	1		U	1
Xylene (total)		U	1.7		U	0.71		U	1.7		U	1.7		U	1.7		U	0.71		U	1.7		U	1.7		U	1.7		U	1.7
Total Chlorinated VOCs	0			0			0			0.51			0.55			0			0			0			0			0		
Total Non-Chlorinated VOCs	0.51			0			0			0			0			12			0			0			0			0		
Total VOCs	0.51			0			0			0.51			0.55			12			0			0			0			0		

TABLE 4
ANALYTICAL RESULTS FOR SHALLOW WELLS
2011 ANNUAL GROUNDWATER SAMPLING EVENT
3200 MAIN STREET, KEOKUK, IOWA

	MW-1-2011			MW-2R-2011			MW-3-2011			MW-6A-2011			MW-10A-2011			MW-13A-2011		
	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit
Volatiles (UG/L)																		
1,1,1-Trichloroethane		U	0.62		U	0.62		U	0.62		U	0.62		U	0.62		U	0.31
1,1,2,2-Tetrachloroethane		U	1.2		U	1.2		U	1.2		U	1.2		U	1.2		U	0.38
1,1,2-Trichloroethane		U	0.98		U	0.98		U	0.98		U	0.98		U	0.98		U	0.36
1,1-Dichloroethane	1	J	0.52	0.72	J	0.52		U	0.52		U	0.52	1.6	J	0.52		U	0.29
1,1-Dichloroethylene		U	0.5		U	0.5		U	0.5		U	0.5		U	0.5		U	0.4
1,2-Dichloroethane		U	0.62		U	0.62		U	0.62		U	0.62		U	0.62		U	0.2
1,2-Dichloroethene		U	1		U	1		U	1		U	1	1.4	J	1	1.2	J	0.54
1,2-Dichloropropane		U	0.62		U	0.62		U	0.62		U	0.62		U	0.62		U	0.25
2-Butanone (MEK)		U	3.9		U	3.9		U	3.9		U	3.9		U	3.9		U	1.8
2-Hexanone		U	3.2		U	3.2		U	3.2		U	3.2		U	3.2		U	2.4
4-Methyl-2-pentanone (MIBK)		U	9.9		U	9.9		U	9.9		U	9.9		U	9.9		U	1.9
Acetone		U	4.7		U	4.7		U	4.7		U	4.7		U	4.7		U	10
Benzene		U	0.5		U	0.5		U	0.5		U	0.5		U	0.5	4.3		0.25
Bromodichloromethane		U	0.49		U	0.49		U	0.49		U	0.49		U	0.49		U	0.25
Bromoform		U	1.4		U	1.4		U	1.4		U	1.4		U	1.4		U	0.35
Carbon disulfide		U	0.53		U	0.53		U	0.53		U	0.53		U	0.53		U	0.36
Carbon tetrachloride		U	0.66		U	0.66		U	0.66		U	0.66		U	0.66		U	0.36
Chlorobenzene		U	0.56		U	0.56		U	0.56		U	0.56		U	0.56		U	0.22
Chloroethane		U	0.92		U	0.92		U	0.92		U	0.92	3.4		0.92		U	0.44
Chloroform		U	0.64		U	0.64		U	0.64		U	0.64		U	0.64		U	0.2
cis-1,2-Dichloroethene	0.71	J	0.56		U	0.56		U	0.56		U	0.56	1.4	J	0.56	1.2		0.24
cis-1,3-Dichloropropene		U	0.48		U	0.48		U	0.48		U	0.48		U	0.48		U	0.2
Dibromochloromethane		U	0.61		U	0.61		U	0.61		U	0.61		U	0.61		U	0.29
Ethylbenzene		U	0.55		U	0.55		U	0.55		U	0.55		U	0.55		U	0.25
Hexane		U	1.3		U	1.3		U	1.3		U	1.3		U	1.3		U	0.66
Isobutyl alcohol		U	5.4		U	5.4		U	5.4		U	5.4		U	5.4		U	23
Methyl bromide (Bromomethane)		U	0.94		U	0.94		U	0.94		U	0.94		U	0.94		U	0.31
Methyl chloride (Chloromethane)		U	0.84		U	0.84		U	0.84		U	0.84		U	0.84		U	0.27
Methylene chloride		U	0.41		U	0.41		U	0.41		U	0.41		U	0.41		U	1
n-Butanol		U	12		U	12		U	12		U	12		U	12		U	33
Styrene		U	0.56		U	0.56		U	0.56		U	0.56		U	0.56		U	0.22
tert-Butyl methyl ether		U	0.73		U	0.73		U	0.73		U	0.73		U	0.73		U	0.28
Tetrachloroethylene		U	0.91		U	0.91		U	0.91		U	0.91		U	0.91		U	0.33
Toluene		U	0.43		U	0.43		U	0.43		U	0.43		U	0.43		U	0.26
trans-1,2-Dichloroethylene		U	0.45		U	0.45		U	0.45		U	0.45		U	0.45		U	0.3
trans-1,3-Dichloropropene		U	0.68		U	0.68		U	0.68		U	0.68		U	0.68		U	0.21
Trichloroethene (TCE)		U	0.52		U	0.52		U	0.52		U	0.52	0.64	J	0.52	1.4		0.36
Vinyl chloride		U	1		U	1		U	1		U	1		U	1	0.94	J	0.4
Xylene (total)		U	1.7		U	1.7		U	1.7	280		1.7		U	1.7	0.81	J	0.71
Metals (MG/L)																		
Iron, Dissolved	10.3		0.1	0.15		0.1		U	0.1	11		0.1	25		0.1	78.7		0.1
Manganese, Dissolved	4.36		0.015	0.768		0.015	1.03		0.015	4.19		0.015	4.07		0.015	9.33		0.015
Dissolved Gases (UG/L)																		
Ethane		U	0.32	0.4	J	0.32		U	0.32		U	0.32		U	0.32	2.2		0.32
Ethene		U	0.43		U	0.43		U	0.43		U	0.43		U	0.43		U	0.43
Methane	232		0.16	356		0.16	263		0.16	3680		0.8	1310		0.8	5710		1.6
Water Quality (MG/L)																		
Alkalinity, Total	580		20	640		20	225		5	222		10	404		20	352		10
Chloride	338		25	54.4		5	80.7		5	1210		250	365		25	1760		50
Nitrate	0.57		0.5		U	0.5		U	0.5	0.59		0.5		U	0.5	0.14		0.11
Nitrate + Nitrite	0.57		1		U	1		U	1	0.59		1		U	1	0.25		0.1
Nitrite		U	0.5		U	0.5		U	0.5		U	0.5		U	0.5	0.11		0.01
Sulfate	26.8		2.5	112		5	27.9		5	5.5		0.5	89.6		25	2.8		0.5
Sulfide		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.8
Total Organic Carbon	7.4		1	4.2		1	2.7		1	10.1		1	10.7		1	29.4		1
Field Parameters																		
Temperature (°C)	25.04			25.02			16.37			23.16			20.25			20.61		
Conductivity (mS/CM)	2.098			0.881			0.586			4.434			1.843			5.361		
pH	6.66			6.75			6.74			7.01			6.79			6.34		
Dissolved Oxygen (MG/L)	0.21			1.46			0.27			1.2			0.18			0.23		
Oxidation-Reduction Potential (mV)	-94.9			-10.2			43.9			-103.4			-114.3			-78.2		
Turbidity (NTU)	4.49			14.1			7.75			13.2			10.9			82		
Summary																		
Total Chlorinated VOCs	1.71			0.72			0			0			8.44			4.74		
Total Non-Chlorinated VOCs	0			0			0			280			0			5.11		
Total VOCs	1.71			0.72			0			280			8.44			9.85		

TABLE 5
ANALYTICAL RESULTS FOR TILL WELLS
2011 ANNUAL GROUNDWATER SAMPLING EVENT
3200 MAIN STREET, KEOKUK, IOWA

	MW-7-2011			MW-10-2011			MW-13-2011			MW-13-2011-DUP			MW-13B-2011			MW-16-2011		
	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit
Volatiles (UG/L)																		
1,1,1-Trichloroethane		U	0.62	152		0.62	15.1		0.31	15.4		0.31		U	0.31		U	0.62
1,1,2,2-Tetrachloroethane		U	1.2		U	1.2	1.4		0.38	1.5		0.38		U	0.38		U	1.2
1,1,2-Trichloroethane		U	0.98	3.9		0.98	4.2		0.36	4.3		0.36		U	0.36		U	0.98
1,1-Dichloroethane	0.61	J	0.52	19.6		0.52	66.7		0.29	66.6		0.29		U	0.29		U	0.52
1,1-Dichloroethylene		U	0.5	264		13	131		0.4	129		0.4		U	0.4		U	0.5
1,2-Dichloroethane		U	0.62		U	0.62	3.7		0.2	3.8		0.2		U	0.2		U	0.62
1,2-Dichloroethene	110		1	29.3		1	310		27	309		27		U	0.54		U	1
1,2-Dichloropropane		U	0.62	8.4		0.62	13.4		0.25	13.5		0.25		U	0.25		U	0.62
2-Butanone (MEK)		U	3.9		U	3.9		U	1.8		U	1.8		U	1.8		U	3.9
2-Hexanone		U	3.2		U	3.2		U	2.4		U	2.4		U	2.4		U	3.2
4-Methyl-2-pentanone (MIBK)		U	9.9		U	9.9		U	1.9		U	1.9		U	1.9		U	9.9
Acetone		U	4.7		U	4.7		U	10		U	10		U	10		U	4.7
Benzene		U	0.5		U	0.5	2.4		0.25	2.4		0.25		U	0.25		U	0.5
Bromodichloromethane		U	0.49		U	0.49		U	0.25		U	0.25		U	0.25		U	0.49
Bromoform		U	1.4		U	1.4		U	0.35		U	0.35		U	0.35		U	1.4
Carbon disulfide		U	0.53	44.2		0.53	1.4		0.36	1.4		0.36		U	0.36		U	0.53
Carbon tetrachloride		U	0.66		U	0.66		U	0.36		U	0.36		U	0.36		U	0.66
Chlorobenzene		U	0.56		U	0.56		U	0.22		U	0.22		U	0.22		U	0.56
Chloroethane		U	0.92		U	0.92		U	0.44		U	0.44		U	0.44		U	0.92
Chloroform	1.9	J	0.64	2.1		0.64	2		0.2	1.9		0.2		U	0.2		U	0.64
cis-1,2-Dichloroethene	109		0.56	29.3		0.56	310		12	309		12		U	0.24		U	0.56
cis-1,3-Dichloropropene		U	0.48		U	0.48		U	0.2		U	0.2		U	0.2		U	0.48
Dibromochloromethane		U	0.61		U	0.61		U	0.29		U	0.29		U	0.29		U	0.61
Ethylbenzene		U	0.55		U	0.55	0.26	J	0.25	0.26	J	0.25		U	0.25		U	0.55
Hexane		U	1.3		U	1.3		U	0.66		U	0.66		U	0.66		U	1.3
Isobutyl alcohol		U	5.4		U	5.4		U	23		U	23		U	23		U	5.4
Methyl bromide (Bromomethane)		U	0.94		U	0.94		U	0.31		U	0.31		U	0.31		U	0.94
Methyl chloride (Chloromethane)		U	0.84		U	0.84		U	0.27		U	0.27		U	0.27		U	0.84
Methylene chloride		U	0.41	4250		10	6390		50	6530		50		U	1		U	0.41
n-Butanol		U	12		U	12		U	33		U	33		U	33		U	12
Styrene		U	0.56		U	0.56		U	0.22		U	0.22		U	0.22		U	0.56
tert-Butyl methyl ether		U	0.73		U	0.73		U	0.28		U	0.28		U	0.28		U	0.73
Tetrachloroethylene	6		0.91	413		23	270		17	272		17	0.33	J	0.33		U	0.91
Toluene		U	0.43		U	0.43	0.58	J	0.26	0.56	J	0.26		U	0.26		U	0.43
trans-1,2-Dichloroethylene	1.5	J	0.45		U	0.45	3.3		0.3	3.1		0.3		U	0.3		U	0.45
trans-1,3-Dichloropropene		U	0.68		U	0.68		U	0.21		U	0.21		U	0.21		U	0.68
Trichloroethene (TCE)	16.7		0.52	966		13	602		18	589		18	0.7	J	0.36		U	0.52
Vinyl chloride	4.6		1		U	1	11.4		0.4	11.5		0.4		U	0.4		U	1
Xylene (total)		U	1.7		U	1.7		U	0.71		U	0.71		U	0.71		U	1.7
Metals (MG/L)																		
Iron, Dissolved		U	0.1	0.203		0.1	0.711		0.1	0.561		0.1	1.39		0.1	60.9		0.01
Manganese, Dissolved	0.979		0.015	2.01		0.015	2.59		0.015	2.61		0.015	0.371		0.015	6.8		0.015
Dissolved Gases (UG/L)																		
Ethane	2		0.32	2.1		0.32	6.23		0.32	6.75		0.32		U	0.32		U	0.32
Ethene		U	0.43	1.1		0.43	6.77		0.43	7.32		0.43		U	0.43		U	0.43
Methane	43.1		0.16	204		0.16	1110		0.16	1060		0.8	4.24		0.16	1470		0.8
Water Quality (MG/L)																		
Alkalinity, Total	444		10	428		20	498		10	338		10	396		10	190		5
Chloride	173		10	138		10	66.9		10	63.2		5	17.9		0.5	2000		250
Nitrate		U	0.5		U	0.5		U	0.11	0.11		0.11	0.13		0.11	0.5		0.5
Nitrate + Nitrite		U	1		U	1		U	0.1	0.17		0.1	0.17		0.1	0.5		1
Nitrite		U	0.5		U	0.5		U	0.01	0.057		0.01	0.043		0.01		U	0.5
Sulfate	221		10	143		10	164		10	173		5	503		50	40.8		2.5
Sulfide		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Total Organic Carbon	2.2		1	2.5		1	3.9		1	3.3		1	3.7		1	7.9		1
Field Parameters																		
Temperature (°C)	20.41			24.75			16.61			16.61			18.02			18.30		
Conductivity (mS/CM)	1.421			1.411			1.08			1.08			1.286			11.440		
pH	6.55			6.55			6.64			6.64			6.89			6.51		
Dissolved Oxygen (MG/L)	0.41			1.93			0.21			0.21			0.28			1.15		
Oxidation-Reduction Potential (mV)	41.9			-14.1			-19.9			-19.9			-153.2			69.2		
Turbidity (NTU)	1.92			1.32			3.04			3.04			2.71			11.7		
Summary																		
Total Chlorinated VOCs	250.31			6137.6			8134.2			8259.6			1.03			0		
Total Non-Chlorinated VOCs	0.00			44.2			4.64			4.62			0			0		
Total VOCs	250.31			6181.8			8138.84			8264.22			1.03			0		

TABLE 6
ANALYTICAL RESULTS FOR PROPERTY LINE AND SENTINEL WELLS
2011 ANNUAL GROUNDWATER SAMPLING EVENT
3200 MAIN STREET, KEOKUK, IOWA

	MW-17A-2011			MW-17B-2011			MW-17B-2011-DUP			MW-19-2011			MW-20-2011			MW-23A-2011			MW-23B-2011		
	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit	Result	Qualifier	Detection Limit
Volatiles (UG/L)																					
1,1,1-Trichloroethane		U	0.62		U	0.62		U	0.62		U	0.62		U	0.62		U	0.62		U	0.62
1,1,2,2-Tetrachloroethane		U	1.2		U	1.2		U	1.2		U	1.2		U	1.2		U	1.2		U	1.2
1,1,2-Trichloroethane		U	0.98		U	0.98		U	0.98		U	0.98		U	0.98		U	0.98		U	0.98
1,1-Dichloroethane		U	0.52		U	0.52		U	0.52		U	0.52		U	0.52		U	0.52		U	0.52
1,1-Dichloroethylene		U	0.5		U	0.5		U	0.5		U	0.5		U	0.5		U	0.5		U	0.5
1,2-Dichloroethane		U	0.62		U	0.62		U	0.62		U	0.62		U	0.62		U	0.62		U	0.62
1,2-Dichloroethene		U	1		U	1		U	1		U	1		U	1		U	1		U	1
1,2-Dichloropropane		U	0.62		U	0.62		U	0.62		U	0.62		U	0.62		U	0.62		U	0.62
2-Butanone (MEK)		U	3.9		U	3.9		U	3.9		U	3.9		U	3.9		U	3.9		U	3.9
2-Hexanone		U	3.2		U	3.2		U	3.2		U	3.2		U	3.2		U	3.2		U	3.2
4-Methyl-2-pentanone (MIBK)		U	9.9		U	9.9		U	9.9		U	9.9		U	9.9		U	9.9		U	9.9
Acetone		U	4.7		U	4.7		U	4.7		U	4.7		U	4.7		U	4.7		U	4.7
Benzene		U	0.5		U	0.5		U	0.5		U	0.5		U	0.5		U	0.5		U	0.5
Bromodichloromethane		U	0.49		U	0.49		U	0.49		U	0.49		U	0.49		U	0.49		U	0.49
Bromoform		U	1.4		U	1.4		U	1.4		U	1.4		U	1.4		U	1.4		U	1.4
Carbon disulfide		U	0.53		U	0.53		U	0.53		U	0.53		U	0.53		U	0.53		U	0.53
Carbon tetrachloride		U	0.66		U	0.66		U	0.66		U	0.66		U	0.66		U	0.66		U	0.66
Chlorobenzene		U	0.56		U	0.56		U	0.56		U	0.56		U	0.56		U	0.56		U	0.56
Chloroethane		U	0.92		U	0.92		U	0.92		U	0.92		U	0.92		U	0.92		U	0.92
Chloroform		U	0.64		U	0.64		U	0.64		U	0.64		U	0.64		U	0.64		U	0.64
cis-1,2-Dichloroethene		U	0.56		U	0.56		U	0.56		U	0.56		U	0.56		U	0.56		U	0.56
cis-1,3-Dichloropropene		U	0.48		U	0.48		U	0.48		U	0.48		U	0.48		U	0.48		U	0.48
Dibromochloromethane		U	0.61		U	0.61		U	0.61		U	0.61		U	0.61		U	0.61		U	0.61
Ethylbenzene		U	0.55		U	0.55		U	0.55		U	0.55		U	0.55		U	0.55		U	0.55
Hexane		U	1.3		U	1.3		U	1.3		U	1.3		U	1.3		U	1.3		U	1.3
Isobutyl alcohol		U	5.4		U	5.4		U	5.4		U	5.4		U	5.4		U	5.4		U	5.4
Methyl bromide (Bromomethane)		U	0.94		U	0.94		U	0.94		U	0.94		U	0.94		U	0.94		U	0.94
Methyl chloride (Chloromethane)		U	0.84		U	0.84		U	0.84		U	0.84		U	0.84		U	0.84		U	0.84
Methylene chloride		U	0.41		U	0.41		U	0.41		U	0.41		U	0.41		U	0.41		U	0.41
n-Butanol		U	12		U	12		U	12		U	12		U	12		U	12		U	12
Styrene		U	0.56		U	0.56		U	0.56		U	0.56		U	0.56		U	0.56		U	0.56
tert-Butyl methyl ether		U	0.73		U	0.73		U	0.73		U	0.73		U	0.73		U	0.73		U	0.73
Tetrachloroethylene		U	0.91		U	0.91		U	0.91		U	0.91		U	0.91		U	0.91		U	0.91
Toluene		U	0.43		U	0.43		U	0.43		U	0.43		U	0.43		U	0.43		U	0.43
trans-1,2-Dichloroethylene		U	0.45		U	0.45		U	0.45		U	0.45		U	0.45		U	0.45		U	0.45
trans-1,3-Dichloropropene		U	0.68		U	0.68		U	0.68		U	0.68		U	0.68		U	0.68		U	0.68
Trichloroethene (TCE)		U	0.52		U	0.52		U	0.52		U	0.52		U	0.52		U	0.52		U	0.52
Vinyl chloride		U	1		U	1		U	1		U	1		U	1		U	1		U	1
Xylene (total)		U	1.7		U	1.7		U	1.7		U	1.7		U	1.7		U	1.7		U	1.7
Metals (MG/L)																					
Iron, Dissolved	0.899		0.1	1.72		0.1	1.46		0.1		U	0.1	0.362		0.1	106		0.1		U	0.1
Manganese, Dissolved	0.815		0.015	0.712		0.015	0.738		0.015	0.0294		0.015	0.949		0.015	5.51		0.015	0.198		0.015
Dissolved Gases (UG/L)																					
Ethane		U	0.32		U	0.32		U	0.32		U	0.32		U	0.32		U	0.32		U	0.32
Ethene		U	0.43		U	0.43		U	0.43		U	0.43		U	0.43		U	0.43		U	0.43
Methane	43.8		0.16	31.7		0.16	32.5		0.16	15.5	J	0.16	610		0.16	2490		1.6	0.34	J	0.16
Water Quality (MG/L)																					
Alkalinity, Total	380		10	408		10	404		10	400		10	456		20	162		5	382		10
Chloride	163		10	52.2		5	51.5		5	179		25	52.6		5	1970		250	29.7		10
Nitrate		U	0.5		U	0.5		U	0.5	1.3		0.5		U	0.5	0.52		0.5	4.5		0.5
Nitrate + Nitrite		U	1		U	1		U	1	1.3		1		U	1	0.52		1	4.5		1
Nitrite		U	0.5		U	0.5		U	0.5		U	0.5		U	0.5		U	0.5		U	0.5
Sulfate	74.9		10	359		25	362		25	232		25	46.8		5	0.53		0.5	185		10
Sulfide		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2		U	0.2
Total Organic Carbon	11.2		1	1.5		1	1.8		1	2		1	3.8		1	27.6		1	2.2		1
Field Parameters																					
Temperature (°C)	17.32			16.59			16.59			15.31			17.28			21.04			18.63		
Conductivity (mS/CM)	1.058			1.129			1.129			1.29			0.944			5.31			1.922		
pH	6.95			6.76			6.76			6.36			7.14			6.64			6.77		
Dissolved Oxygen (MG/L)	2.85			0.13			0.13			0.48			3.38			0.65			0.24		
Oxidation-Reduction Potential (mV)	-83.4			-46.2			-46.2			60.1			-27.1			-98.6			57.9		
Turbidity (NTU)	10.2			2.61			2.61			3.59			22.1			6.98			13.2		
Total Chlorinated VOCs	0			0			0			0			0			0			0		
Total Non-Chlorinated VOCs	0			0			0			0			0			0			0		
Total VOCs	0			0			0			0			0			0			0		

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-01-2011Personnel: CA DKWell: MW-01QA/QC Sample Yes (No)

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft): 5.40WL Date: 6-8-11WL Time: 950

Well Development/Purging

Date: 6-8-11Top of Screen (ft TOC) 4.60Bottom of Screen (ft TOC) 14.60Well Depth, Constructed (ft) 16.00Well Depth, Sounded (ft): Pump Depth (ft TOC): 10'Method/Pump Type: Bladder PumpWater Level w/ Pump in (ft) (before): 5.25(after): 6.19Casing Diameter (in): 4

Well volume above pump intake:

$$[(\text{ ft} \times 1.43 \text{ gal/ft}) + (\text{ ft} - \text{ ft}) \times 0.66 \text{ ft/gal}] = \text{ gal} \times \text{ L/gal} = \text{ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5 \text{ L} + (\text{ ft} \times 0.022 \text{ L/ft}) + 0.5 \text{ L} + 2.6 \text{ L} = \text{ L}$$

Time	1005	1010	1015	1020	1025	1030	1035	1040	1045
Temperature (°C)	23.00	24.00	24.78	25.02	24.62	24.51	24.69	24.82	25.04
Conduct (mmhos/cm)	2.008	2.053	2.087	2.100	2.086	2.077	2.083	2.089	2.098
pH	6.59	6.62	6.63	6.64	6.65	6.65	6.65	6.66	6.66
D.O. (mg/l)	0.92	0.68	0.53	0.55	0.39	0.32	0.28	0.24	0.21
ORP (mv)	-92.3	-91.1	-91.5	-95.2	-95.4	-94.7	-93.3	-93.2	-94.9
Turbidity (NTU)	5.91	5.49	5.94	4.71	4.82	4.33	4.39	3.86	4.49
Water Level (ft)	5.66	5.76	5.83	5.89	5.97	5.99	6.08	6.15	6.19
Pump Rate (L/min)	75	75	75	75	75	75	75	75	75
Volume (L)	.5	1	1.25	1.75	2.0	2.25	2.5	3.75	4.0

Sampling

Date: 6-8-11 Time: 1045 Method: Bladder Pump

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes:

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-02R-2011Personnel: CA/DKWell: MW-02RQA/QC Sample Yes No

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft): 8.38WL Date: 6-8-11WL Time: 1225

Well Development/Purging

Date: 6-8-11Top of Screen (ft TOC) 5.20Bottom of Screen (ft TOC) 15.20Well Depth, Constructed (ft) 15.20Well Depth, Sounded (ft): Pump Depth (ft TOC): 10'Method/Pump Type: Bladder PumpWater Level w/ Pump in (ft) (before): 8.35(after): 9.18Casing Diameter (in): 2

Well volume above pump intake:

$$[(\text{ ft} \times 1.43 \text{ gal/ft}) + (\text{ ft} - \text{ ft})] \times 0.66 \text{ ft/gal} = \text{ gal} \times \text{ L/gal} = \text{ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5\text{L} + (\text{ ft} \times 0.022\text{L/ft}) + 0.5\text{L} + 2.6\text{L} = \text{ L}$$

Time	1245	1250	1255	1300	1305	1310	1315	1320	1325
Temperature (°C)	23.23	23.88	24.39	24.67	24.83	24.97	24.84	24.72	24.66
Conduct (mmhos/cm)	0.928	0.930	0.923	0.912	0.896	0.835	0.874	0.884	0.858
pH	7.02	6.93	6.86	6.83	6.80	6.78	6.76	6.76	6.75
D.O. (mg/l)	6.64	4.94	3.86	3.40	3.08	2.91	2.66	2.50	2.31
ORP (mv)	19.2	22.4	20.4	20.5	21.3	20.3	19.9	19.3	17.2
Turbidity (NTU)	540	334	248	199	152	115	84.0	62.1	48.7
Water Level (ft)	8.70	8.74	8.84	8.89	8.94	9.00	9.08	9.12	9.18
Pump Rate (L/min)	60	60	50	50	50	50	50	50	50
Volume (L)	.3	.5	.75	1	1.25	1.5	1.75	1.90	2

* See Continuation Sheet

Sampling

Date: 6-8-11Time: Method: Bladder Pump

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes:

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.0 t00 tSample Number: MW-02 R-2011

Personnel: _____

Well: Continuation Sheet

QA/QC Sample Yes No

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft): _____

WL Date: _____

WL Time: _____

Well Development/Purging

Date: _____

Top of Screen (ft TOC) _____

Bottom of Screen (ft TOC) _____

Well Depth, Constructed (ft) _____

Well Depth, Sounded (ft): _____

Pump Depth (ft TOC): _____

Method/Pump Type: Bladder Pump

Water Level w/ Pump in (ft) (before): _____ (after): _____

Casing Diameter (in): 4

Well volume above pump intake:

$$[(\text{_____ ft} \times 0.78 \text{ gal/ft}) + (\text{_____ ft} - \text{_____ ft})] \times 0.17 \text{ ft/gal} = \text{_____ gal} \times \text{_____ L/gal} = \text{_____ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5 \text{ L} + (\text{_____ ft} \times 0.022 \text{ L/ft}) + 0.5 \text{ L} + 2.6 \text{ L} = \text{_____ L}$$

* Continuation sheet

Time	1330	1335	1340	1345	1350	1355			
Temperature (°C)	24.56	24.60	24.63	24.69	24.38	25.02			
Conduct (mmhos/cm)	0.855	0.856	0.859	0.864	0.873	0.881			
pH	6.74	6.72	6.75	6.75	6.75	6.75			
D.O. (mg/l)	2.12	1.91	1.75	1.64	1.49	1.46			
ORP (mv)	14.0	11.6	7.6	3.2	-2.8	-10.2			
Turbidity (NTU)	35.0	27.1	21.2	17.6	14.2	14.1			
Water Level (ft)	9.23	9.31	9.36	9.40	9.47	9.52			
Pump Rate (L/min)	50	50	50	50	50	50			
Volume (L)	2.1	2.25	2.4	2.6	2.8	3.0			

Sampling

Date: _____ Time: _____ Method: _____

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes:

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-03-2011Personnel: KDS/WEBWell: MW-03QA/QC Sample Yes No

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft): _____

WL Date: _____

WL Time: _____

Well Development/Purging

Date: 6-8-2011Top of Screen (ft TOC) 4.70Bottom of Screen (ft TOC) 14.70Well Depth, Constructed (ft) 16.00

Well Depth, Sounded (ft): _____

Pump Depth (ft TOC): 12.60Method/Pump Type: Bladder PumpWater Level w/ Pump in (ft) (before): 11.76(after): 13.09 12.28Casing Diameter (in): 4

Well volume above pump intake:

$$[(\text{_____ ft} \times 1.43 \text{ gal/ft}) + (\text{_____ ft} - \text{_____ ft})] \times 0.66 \text{ ft/gal} = \text{_____ gal} \times \text{_____ L/gal} = \text{_____ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5 \text{ L} + (\text{_____ ft} \times 0.022 \text{ L/ft}) + 0.5 \text{ L} + 2.6 \text{ L} = \text{_____ L}$$

Time	0955	1000	1005	1010	1015	1020			
Temperature (°C)	16.41	16.60	16.49	16.40	16.37				
Conduct (mmhos/cm)	0.564	0.566	0.570	0.581	0.586				
pH	6.88	6.79	6.79	6.76	6.74				
D.O. (mg/l)	0.99	0.92	0.98	0.96	0.97				
ORP (mv)	83.9	76.0	63.10	50.00	43.90				
Turbidity (NTU)	15.0	9.0	8.6	9.63	1.75				
Water Level (ft)	12.04	12.10	12.14	12.23	12.28				
Pump Rate (L/min)	0.100	0.100	0.100	0.100	0.100				
Volume (L)	1.5	2	2.5	3.0	3.5				

Sampling

Date: 6-8-2011 Time: 1020 Method: Bladder Pump

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes:

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-06A-2011Personnel: KDS / WEBWell: MW-06AQA/QC Sample Yes No

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft): 3.82WL Date: 6-8-11WL Time: 1100

Well Development/Purging

Date: 6-8-11Top of Screen (ft TOC) 4.20Bottom of Screen (ft TOC) 14.20Well Depth, Constructed (ft) 16.00Well Depth, Sounded (ft): Pump Depth (ft TOC): 10'Method/Pump Type: Bladder PumpWater Level w/ Pump in (ft) (before): 3.82(after): 5.55 4.38Casing Diameter (in): 2

Well volume above pump intake:

$$[(\text{ ft} \times 0.78\text{gal/ft}) + (\text{ ft} - \text{ ft})] \times 0.17\text{ft/gal} = \text{ gal} \times \text{ L/gal} = \text{ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5\text{L} + (\text{ ft} \times 0.022\text{L/ft}) + 0.5\text{L} + 2.6\text{L} = \text{ L}$$

Time	1115	1120	1125	1130	1135	1140			
Temperature (°C)	20.45	21.80	22.88	23.22	23.16				
Conduct (mmhos/cm)	4.168	4.306	4.425	4.461	4.434				
pH	7.19	7.13	7.06	7.06	7.01				
D.O. (mg/l)	11.90	11.90	10.72	1.06	1.20				
ORP (mv)	-102.1	-102.20	-102.7	-103.30	-103.40				
Turbidity (NTU)	11.0	10.70	9.72	9.72	13.20				
Water Level (ft)	4.12	4.18	4.31	4.32	4.38				
Pump Rate (L/min)	0.90	0.90	0.90	0.90	0.90				
Volume (L)	0.5	0.8	0.2	1.6	2.0				

Sampling

Date: 6-8-11 Time: 1140 Method: Bladder Pump

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes:

* First DO readings were read from % rather than mg/L

1115 - 108

1120 - 1.00

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-07-2011Personnel: KDS/WEBWell: MW-07QA/QC Sample Yes ☒ No ☐

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft): 9.24WL Date: 6-8-2011WL Time: 1325

Well Development/Purging

Date: 6-8-2011Top of Screen (ft TOC) 30.00Bottom of Screen (ft TOC) 39.80Well Depth, Constructed (ft) 41.00Well Depth, Sounded (ft): Pump Depth (ft TOC): 25'Method/Pump Type: Bladder PumpWater Level w/ Pump in (ft) (before): 8.26(after): 13.42 11.46Casing Diameter (in): 2

Well volume above pump intake:

$$[(\text{ ft} \times 0.78\text{gal/ft}) + (\text{ ft} - \text{ ft}) \times 0.17\text{ft/gal}] = \text{ gal} \times \text{ L/gal} = \text{ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5\text{L} + (\text{ ft} \times 0.022\text{L/ft}) + 0.5\text{L} + 2.6\text{L} = \text{ L}$$

Time	1350	1355	1400	1405	1410	1415			
Temperature (°C)	21.91	21.41	20.49	20.44	20.41				
Conduct (mmhos/cm)	1.478	1.452	1.422	1.420	1.421				
pH	6.68	6.63	6.58	6.55	6.55				
D.O. (mg/l)	1.23	0.83	0.55	0.43	0.41				
ORP (mv)	48.6	45.7	43.8	43.90	41.90				
Turbidity (NTU)	6.19	5.34	3.34	2.20	1.92				
Water Level (ft)	10.10	10.46	11.02	11.34	11.46				
Pump Rate (L/min)	0.140	0.140	0.140	0.140	0.140				
Volume (L)	2L	3	4	4.5	5.5				

Sampling

Date: 6-8-2011 Time: 1415 Method: Bladder Pump

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes:

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-10-2011Personnel: CA DKWell: MW-10

QA/QC Sample

Yes

(No)

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft):

0.91WL Date: 6-8-11WL Time: 1520

Well Development/Purging

Date: 6-8-11Top of Screen (ft TOC) 19.2Bottom of Screen (ft TOC) 29.2Well Depth, Constructed (ft) 30.00

Well Depth, Sounded (ft):

Pump Depth (ft TOC):

25'

Method/Pump Type:

Bladder Pump

Water Level w/ Pump in (ft)

(before):

1.10

(after):

2.75

Casing Diameter (in):

4

Well volume above pump intake:

$$[(\text{ft} \times 1.43 \text{ gal/ft}) + (\text{ft} - \text{ft})] \times 0.66 \text{ ft/gal} = \text{gal} \times \text{L/gal} = \text{L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5 \text{ L} + (\text{ft} \times 0.022 \text{ L/ft}) + 0.5 \text{ L} + 2.6 \text{ L} = \text{L}$$

Time	1535	1540	1545	1550	1555	1600	1605	1610	1615
Temperature (°C)	22.92	21.93	22.05	22.07	22.22	22.04	21.80	21.42	21.39
Conduct (mmhos/cm)	1.36	1.327	1.330	1.330	1.335	1.333	1.328	1.316	1.317
pH	6.58	6.52	6.53	6.54	6.54	6.53	6.54	6.49	6.51
D.O. (mg/l)	0.98	0.73	0.70	0.77	0.87	1.00	1.17	1.32	1.47
ORP (mv)	-13.7	-13.4	-14.3	-14.4	-15.4	-14.5	-14.4	-14.4	-14.2
Turbidity (NTU)	1.54	1.54	1.88	1.11	1.21	1.40	1.29	1.62	1.40
Water Level (ft)	1.55	1.78	1.95	2.12	2.28	2.41	2.55	2.65	2.74
Pump Rate (L/min)	125	125	125	125	125	125	125	125	100
Volume (L)	1	1.5	2	2.5	3	3.5	4.0	4.25	4.75

*
see
Construction
Sheet

Sampling

Date: 6-8-11Time: 16:30Method: Bladder Pump

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes:

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-10-2011

Personnel: _____

Well: Continuation Sheet

QA/QC Sample Yes No

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft): _____

WL Date: _____

WL Time: _____

Well Development/Purging

Date: _____

Top of Screen (ft TOC) _____

Bottom of Screen (ft TOC) _____

Well Depth, Constructed (ft) _____

Well Depth, Sounded (ft): _____

Pump Depth (ft TOC): _____

Method/Pump Type: Bladder Pump

Water Level w/ Pump in (ft) (before): _____ (after): _____

Casing Diameter (in): 4

Well volume above pump intake:

$$[(\text{_____ ft} \times 0.78 \text{ gal/ft}) + (\text{_____ ft} - \text{_____ ft}) \times 0.17 \text{ ft/gal}] = \text{_____ gal} \times \text{_____ L/gal} = \text{_____ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5 \text{ L} + (\text{_____ ft} \times 0.022 \text{ L/ft}) + 0.5 \text{ L} + 2.6 \text{ L} = \text{_____ L}$$

Time	<u>1620</u>	<u>1625</u>	<u>1630</u>						
Temperature (°C)	<u>23.43</u>	<u>24.75</u>							
Conduct (mmhos/cm)	<u>1.372</u>	<u>1.411</u>							
pH	<u>6.55</u>	<u>6.55</u>							
D.O. (mg/l)	<u>1.70</u>	<u>1.93</u>							
ORP (mv)	<u>-15.2</u>	<u>-14.1</u>							
Turbidity (NTU)	<u>1.29</u>	<u>1.32</u>							
Water Level (ft)	<u>2.75</u>	<u>2.75</u>							
Pump Rate (L/min)	<u>100</u>	<u>100</u>							
Volume (L)	<u>5.25</u>	<u>5.75</u>							

Sampling

Date: 6 Time: _____ Method: _____

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes:

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-10A-2011Personnel: KDS / WEBWell: MW-10AQA/QC Sample Yes No

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft): 1.89WL Date: 6-8-11WL Time: 1320

Well Development/Purging

Date: 6-8-11Top of Screen (ft TOC) 4.90Bottom of Screen (ft TOC) 7.10Well Depth, Constructed (ft) 8.00Well Depth, Sounded (ft): Pump Depth (ft TOC): 4.5Method/Pump Type: Bladder PumpWater Level w/ Pump in (ft) (before): 2.40 (after): 3.20Casing Diameter (in): 2

Well volume above pump intake:

$$[(\text{ ft} \times 0.78\text{gal/ft}) + (\text{ ft} - \text{ ft})] \times 0.17\text{ft/gal} = \text{ gal} \times \text{ L/gal} = \text{ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5\text{L} + (\text{ ft} \times 0.022\text{L/ft}) + 0.5\text{L} + 2.6\text{L} = \text{ L}$$

Time	1530	1535	1540	1545	1550	1555			
Temperature (°C)	21.24	21.12	20.75	20.63	20.37	20.25			
Conduct (mmhos/cm)	1.892	1.886	1.869	1.861	1.849	1.843			
pH	6.69	6.74	6.77	6.78	6.79	6.79			
D.O. (mg/l)	2.10	2.49	0.31	0.21	0.20	0.18			
ORP (mv)	-117.0	-118.3	-117.3	-116.4	-114.9	-114.3			
Turbidity (NTU)	157.0	78.6	39.7	20.2	17.9	10.9			
Water Level (ft)	2.86	2.89	3.00	3.10	3.14	3.20			
Pump Rate (L/min)	0.150	0.150	0.150	0.150	0.150	0.150			
Volume (L)	0.5	1.0	1.7	2.3	2.8	3.4			

Sampling

Date: 6-8-11 Time: 1600 Method: Bladder Pump

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes:

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Re-sample

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-13-2011Personnel: CA/WBWell: MW-13QA/QC Sample ☒ Yes ☐ No

Dup

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft):

1.97WL Date: 6-23-11

WL Time: _____

Well Development/Purging

Date: 6-23-11Top of Screen (ft TOC) 17.10Bottom of Screen (ft TOC) 27.10Well Depth, Constructed (ft) 29.00

Well Depth, Sounded (ft): _____

Pump Depth (ft TOC): 22'Method/Pump Type: Bladder PumpWater Level w/ Pump in (ft) (before): 1.32(after): 3.70Casing Diameter (in): 2

Well volume above pump intake:

$$[(\text{_____ ft} \times 0.78 \text{ gal/ft}) + (\text{_____ ft} - \text{_____ ft}) \times 0.17 \text{ ft/gal}] = \text{_____ gal} \times \text{_____ L/gal} = \text{_____ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5 \text{ L} + (\text{_____ ft} \times 0.022 \text{ L/ft}) + 0.5 \text{ L} + 2.6 \text{ L} = \text{_____ L}$$

Time	915	920	925	930	935	940	945	950	955
Temperature (°C)	17.39	17.18	17.05	16.92	16.90	16.76	16.60	16.61	
Conduct (mmhos/cm)	1.014	1.008	1.007	1.004	1.048	1.067	1.076	1.080	
pH	6.66	6.69	6.70	6.64	6.67	6.66	6.66	6.64	
D.O. (mg/l)	0.40	0.54	0.27	0.23	0.23	0.24	0.23	0.21	
ORP (mv)	-17.0	-22.3	-23.7	-19.1	-17.7	-18.5	-19.3	-19.9	
Turbidity (NTU)	25.2	14.6	7.86	5.76	4.39	3.18	3.11	3.04	
Water Level (ft)	2.80	3.02	3.23	3.36	3.48	3.55	3.64	3.71	
Pump Rate (L/min)	150	150	150	150	150	150	150	150	
Volume (L)	1	1.75	2.25	3.5	4.25	6.0	5.75	6.5	

Sampling

Date: 6-23-11Time: 955Method: Bladder Pump

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes:

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Re-sample

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-13A-2011Personnel: CA/WBWell: MW-13AQA/QC Sample Yes No

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft): 2.75WL Date: 6-23-11WL Time: 7:45

Well Development/Purging

Date: 6-23-11Top of Screen (ft TOC) 4.80Bottom of Screen (ft TOC) 9.80Well Depth, Constructed (ft) 11.00Well Depth, Sounded (ft): Pump Depth (ft TOC): 6'Method/Pump Type: Bladder PumpWater Level w/ Pump in (ft) (before): 2.11(after): 4.99Casing Diameter (in): 2

Well volume above pump intake:

$$[(\text{ ft} \times 0.78\text{gal/ft}) + (\text{ ft} - \text{ ft})] \times 0.17\text{ft/gal} = \text{ gal} \times \text{ L/gal} = \text{ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5\text{L} + (\text{ ft} \times 0.022\text{L/ft}) + 0.5\text{L} + 2.6\text{L} = \text{ L}$$

Time	8:00	8:05	8:10	8:15	8:20	8:25	8:30	8:35	
Temperature (°C)	20.53	20.67	20.83	20.29	20.82	20.70	20.61		
Conduct (mmhos/cm)	5.316	5.333	5.352	5.364	5.368	5.368	5.361		
pH	6.31	6.32	6.33	6.33	6.34	6.33	6.34		
D.O. (mg/l)	1.19	0.54	0.36	0.32	0.26	0.23	0.23		
ORP (mv)	-78.0	-76.4	-72.5	-73.4	-74.8	-76.7	-78.2		
Turbidity (NTU)	104	98.7	95.9	93.7	90.7	85.7	82.0		
Water Level (ft)	3.10	3.52	3.91	4.25	4.52	4.79	4.99		
Pump Rate (L/min)	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Volume (L)	1	2.6	2.0	2.1	2.2	2.3	2.4		

Sampling

Date: 6-23-11 Time: 8:35 Method: Bladder Pump

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes: WL will not stabilize

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Re - Sample

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-13B-2011Personnel: CA/w/BWell: MW-13BQA/QC Sample Yes No

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft): 2.05WL Date: 6.23.11WL Time: 1045

Well Development/Purging

Date: 6.23.11Top of Screen (ft TOC) 39.90Bottom of Screen (ft TOC) 49.90Well Depth, Constructed (ft) 53.00Well Depth, Sounded (ft): Pump Depth (ft TOC): 45'Method/Pump Type: Bladder PumpWater Level w/ Pump in (ft) (before): 0.0(after): 7.80Casing Diameter (in): 2

Well volume above pump intake:

$$[(\text{ ft} \times 0.78\text{gal/ft}) + (\text{ ft} - \text{ ft}) \times 0.17\text{ft/gal}] = \text{ gal} \times \text{ L/gal} = \text{ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5\text{L} + (\text{ ft} \times 0.022\text{L/ft}) + 0.5\text{L} + 2.6\text{L} = \text{ L}$$

Time	1055	1100	1105	1110	1115	1120	1125	1130	1135
Temperature (°C)	18.74	19.72	19.63	19.28	18.79	18.50	18.21	18.16	18.02
Conduct (mmhos/cm)	1.300	1.329	1.335	1.326	1.316	1.301	1.293	1.288	1.286
pH	6.86	6.88	6.89	6.89	6.88	6.89	6.87	6.87	6.89
D.O. (mg/l)	0.58	0.56	0.50	0.43	0.39	0.37	0.34	0.30	0.28
ORP (mv)	-125.4	-131.2	-136.1	-140.5	-142.6	-143.7	-143.2	-146.5	-152.2
Turbidity (NTU)	7.34	6.73	6.33	5.02	4.22	3.75	3.60	2.84	2.71
Water Level (ft)	2.65	3.25	3.75	4.52	5.00	5.60	6.29	6.81	7.35
Pump Rate (L/min)	100	100	100	100	100	100	100	100	100
Volume (L)	1	1.2	1.5	1.7	1.9	2.0	2.5	3.5	3.9

Sampling

Date: 6.23.11Time: 1140Method: Bladder Pump

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes:

Well overflowed when pump was lowered. WL will not stabilize.

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: t6530531.01001Sample Number: MW-16-2011Personnel: CA/DKWell: MW-16QA/QC Sample Yes (No)

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft): 2.99WL Date: 6-7-11WL Time: 9:00

Well Development/Purging

Date: 6-7-11Top of Screen (ft TOC) 24.60Bottom of Screen (ft TOC) 34.60Well Depth, Constructed (ft) 36.00Well Depth, Sounded (ft): Pump Depth (ft TOC): ~~24~~ 30Method/Pump Type: Bladder PumpWater Level w/ Pump in (ft) (before): 2.21 (after): 5.25Casing Diameter (in): 2

Well volume above pump intake:

$$[(\text{ ft} \times 0.78\text{gal/ft}) + (\text{ ft} - \text{ ft})] \times 0.17\text{ft/gal} = \text{ gal} \times \text{ L/gal} = \text{ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5\text{L} + (\text{ ft} \times 0.022\text{L/ft}) + 0.5\text{L} + 2.6\text{L} = \text{ L}$$

Time	9:35	9:40	9:45	9:50	9:55	10:00	10:05	10:10	10:15	10:20
Temperature (°C)	19.30	19.25	19.05	18.67	18.65	18.40	18.41	18.27	18.27	18.30
Conduct (mmhos/cm)	12.78	12.70	12.55	12.31	12.15	11.93	11.76	11.54	11.43	11.44
pH	6.33	6.39	6.40	6.42	6.44	6.45	6.48	6.49	6.50	6.51
D.O. (mg/l)	1.96	1.60	1.40	1.26	1.20	1.16	1.14	1.15	1.16	1.15
ORP (mv)	52.7	60.8	63.3	64.3	65.5	66.4	67.7	68.6	69.3	69.2
Turbidity (NTU)	14.9	18.7	15.3	14.9	12.1	11.4	11.7	11.3	11.9	11.9
Water Level (ft)	3.44	3.68	4.00	4.16	4.40	4.55	4.90	4.98	5.10	5.25
Pump Rate (L/min)	100	100	100	100	100	100	100	100	100	100
Volume (L)	.7	1.5	2	2.5	3.0	3.5	4.00	4.5	5.5	6

Sampling

Date: 06.07.11 Time: Method: Bladder Pump

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes: 100 LPM @ 525'

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-17A-2011Personnel: KDS / WEBWell: MW-17AQA/QC Sample Yes ☒ No ☐

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft): _____

WL Date: _____

WL Time: _____

Well Development/Purging

Date: 6-7-2011Top of Screen (ft TOC) 4.90Bottom of Screen (ft TOC) 9.90Well Depth, Constructed (ft) 11.00

Well Depth, Sounded (ft): _____

Pump Depth (ft TOC): 7.90Method/Pump Type: WEB Bladder PumpWater Level w/ Pump in (ft) (before): 2.49(after): 8.14 7.75Casing Diameter (in): 2

Well volume above pump intake:

$$[(\text{_____ ft} \times 0.78 \text{ gal/ft}) + (\text{_____ ft} - \text{_____ ft})] \times 0.17 \text{ ft/gal} = \text{_____ gal} \times \text{_____ L/gal} = \text{_____ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5 \text{ L} + (\text{_____ ft} \times 0.022 \text{ L/ft}) + 0.5 \text{ L} + 2.6 \text{ L} = \text{_____ L}$$

Time	1035	1040	1045	1050	1055	1105+	1110	1115	1120
Temperature (°C)	16.38	15.57	14.60	15.27	16.0	16.94	17.13	17.21	17.32
Conduct (mmhos/cm)	0.876	0.926	0.935	0.959	0.985	1.018	1.034	1.047	1.058
pH	6.91	6.93	6.81	6.96	7.03	7.05	7.04	6.98	6.95
D.O. (mg/l)	6.79	6.23	4.48	3.76	4.09	4.31	3.82	3.17	2.85
ORP (mv)	-46.3	-55.70	-64.90	-77.40	-60.1	-65.6	-75.5	-79.2	-83.4
Turbidity (NTU)	6.7	32.70	17.00	14.10	16.10	13.8	12.1	11.80	10.20
Water Level (ft)	6.81	7.61	~7.90	~7.90	~7.90	~7.90	~7.90	7.80	7.75
Pump Rate (L/min)	0.45	0.45	0.150	0.150	0.100	0.125	0.125	0.125	0.125
Volume (L)	1.0	2.0	2.4	2.9	3.3	4.3	4.9	5.8	6.4

Sampling

Date: 6-7-2011 Time: 1120Method: Bladder Pump

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes:

*Trying to adjust pump speed in order to allow well to recharge.

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-17B-2011Personnel: K S/ WEBWell: MW-17B

QA/QC Sample

☒ Yes

No

Duplicate

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft): _____

WL Date: _____

WL Time: _____

Well Development/Purging

Date: 6/7/2011Top of Screen (ft TOC) 23.60Bottom of Screen (ft TOC) 33.60Well Depth, Constructed (ft) 35.00

Well Depth, Sounded (ft): _____

Pump Depth (ft TOC): 30.00Method/Pump Type: Bladder PumpWater Level w/ Pump in (ft) (before): *overflow when pump inserted* (after): 2.14Casing Diameter (in): 2

Well volume above pump intake:

$$[(\text{_____ ft} \times 0.78 \text{ gal/ft}) + (\text{_____ ft} - \text{_____ ft})] \times 0.17 \text{ ft/gal} = \text{_____ gal} \times \text{_____ L/gal} = \text{_____ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5 \text{ L} + (\text{_____ ft} \times 0.022 \text{ L/ft}) + 0.5 \text{ L} + 2.6 \text{ L} = \text{_____ L}$$

Time	0835	0840	0845	0850	0855	0900	0905		
Temperature (°C)	15.29	16.40	16.20	16.42	16.53	16.59			
Conduct (mmhos/cm)	1.094	1.124	1.120	1.125	1.123	1.129			
pH	6.69	6.76	6.76	6.76	6.76	6.76			
D.O. (mg/l)	0.21	0.24	0.17	0.17	0.16	0.13			
ORP (mv)	-20.40	-38.80	-40.60	-42.20	-44.20	-46.20			
Turbidity (NTU)	2.77	2.79	2.71	2.63	2.57	2.61			
Water Level (ft)	2.65	2.21	2.14	2.13	2.12	2.14			
Pump Rate (L/min)	250	250	250	250	250	250			
Volume (L)	1.0	2.0	3.0	4.0	5.0	6.0			

Sampling

Date: 6-7-11 Time: 0905 Method: Bladder Pump

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes: *Well overflowed when pump was inserted*

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-19-2011Personnel: CA/DKWell: MW-19

QA/QC Sample

☒ Yes ☐ NoMS
MSD

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft):

1.85WL Date: 6.8.11WL Time: 7:45

Well Development/Purging

Date: 6.8.11Top of Screen (ft TOC) 18.00Bottom of Screen (ft TOC) 27.40Well Depth, Constructed (ft) 29.00

Well Depth, Sounded (ft):

Pump Depth (ft TOC):

23.00

Method/Pump Type:

Bladder Pump

Water Level w/ Pump in (ft)

(before):

1.85

(after):

3.20

Casing Diameter (in):

2

Well volume above pump intake:

$$[(\text{ft} \times 0.78\text{gal/ft}) + (\text{ft} - \text{ft})] \times 0.17\text{ft/gal} = \text{gal} \times \text{L/gal} = \text{L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5\text{L} + (\text{ft} \times 0.022\text{L/ft}) + 0.5\text{L} + 2.6\text{L} = \text{L}$$

Time	800	805	810	815	820	825	830	835	840
Temperature (°C)	15.35	15.25	15.08	15.03	15.15	15.24	15.24	15.31	
Conduct (mmhos/cm)	1.283	1.278	1.261	1.255	1.265	1.281	1.284	1.290	
pH	6.26	6.28	6.30	6.32	6.32	6.35	6.35	6.36	
D.O. (mg/l)	1.19	1.13	0.91	0.74	0.61	0.54	0.51	0.48	
ORP (mv)	45.0	40.1	44.9	48.7	54.2	57.3	58.5	60.1	
Turbidity (NTU)	26.1	15.9	6.98	4.82	3.72	3.48	3.62	3.59	
Water Level (ft)	3.05	3.08	3.15	3.20	3.20	3.20	3.20	3.20	
Pump Rate (L/min)	150	150	150	150	150	150	150	150	
Volume (L)	0.5	1	2	3	3.5	4.25	4.75	5.25	

Sampling

Date: 6.8.11Time: 8:45Method: Bladder Pump

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes:

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-20-2011Personnel: KDS/WEBWell: MW-20QA/QC Sample Yes No

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft): _____

WL Date: _____

WL Time: _____

Well Development/Purging

Date: 6-8-2011Top of Screen (ft TOC) 28.00Bottom of Screen (ft TOC) 37.50Well Depth, Constructed (ft) 39.00

Well Depth, Sounded (ft): _____

Pump Depth (ft TOC): 33.00Method/Pump Type: web Bladder PumpWater Level w/ Pump in (ft) (before): 6.22(after): 14.01 11.50Casing Diameter (in): 2

Well volume above pump intake:

$$[(\text{_____ ft} \times 0.78 \text{ gal/ft}) + (\text{_____ ft} - \text{_____ ft})] \times 0.17 \text{ ft/gal} = \text{_____ gal} \times \text{_____ L/gal} = \text{_____ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5 \text{ L} + (\text{_____ ft} \times 0.022 \text{ L/ft}) + 0.5 \text{ L} + 2.6 \text{ L} = \text{_____ L}$$

Time	0820	0825	0830	0835	0840	0845	0850		
Temperature (°C)	18.06	17.53	17.02	17.08	17.80	16.91	17.28		
Conduct (mmhos/cm)	0.964	0.954	0.945	0.945	0.951	0.938	0.944		
pH	6.89	7.00	7.08	7.08	7.08	7.15	7.14		
D.O. (mg/l)	5.80	4.63	4.71	4.55	4.02	3.58	3.38		
ORP (mv)	-10.3	-8.4	-21.10	-21.5	-25.4	-25.20	-27.10		
Turbidity (NTU)	118.0	108.0	68.8	45.0	26.4	22.80	22.10		
Water Level (ft)	7.91	8.86	10.03	10.34	11.16	11.43	11.50		
Pump Rate (L/min)	0.100	0.100	0.100	0.100	0.100	0.100	0.100		
Volume (L)	0.5	0.9	1.4	1.9	2.3	2.8	3.5		

Sampling

Date: 6-8-2011 Time: 0855 Method: Bladder Pump

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes:

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-23A-2011Personnel: KDS/NEBWell: MW-23AQA/QC Sample Yes ☒ No ☐

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft): _____

WL Date: _____

WL Time: _____

Well Development/Purging

Date: 6-7-11Top of Screen (ft TOC) 4.70Bottom of Screen (ft TOC) 7.50Well Depth, Constructed (ft) 9.50

Well Depth, Sounded (ft): _____

Pump Depth (ft TOC): 5.00-6.40Method/Pump Type: WCB Bladder PumpWater Level w/ Pump in (ft) (before): 2.80(after): 4.43 5.44Casing Diameter (in): 2

Well volume above pump intake:

$$[(\text{_____ ft} \times 0.78 \text{ gal/ft}) + (\text{_____ ft} - \text{_____ ft})] \times 0.17 \text{ ft/gal} = \text{_____ gal} \times \text{_____ L/gal} = \text{_____ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5 \text{ L} + (\text{_____ ft} \times 0.022 \text{ L/ft}) + 0.5 \text{ L} + 2.6 \text{ L} = \text{_____ L}$$

Time	1330	1335	1340	1345	1350	1355			
Temperature (°C)	20.23	21.22	21.02	21.03	21.04				
Conduct (mmhos/cm)	5.238	5.359	5.326	5.314	5.310				
pH	6.65	6.64	6.64	6.64	6.64				
D.O. (mg/l)	0.78	0.20	1.00	0.76	0.65				
ORP (mv)	-95.70	-96.30	-98.40	-98.60	-98.60				
Turbidity (NTU)	4.56	25.40	7.63	6.89	6.98				
Water Level (ft)	4.98	5.33	5.41	5.44	5.44				
Pump Rate (L/min)	0.04	0.04	0.05	0.05	0.05				
Volume (L)	0.5	0.6	0.8	0.95	0.9				

Sampling

Date: 6-7-11 Time: 1355 Method: Bladder Pump

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Aik	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes:

Ran well dry

GROUNDWATER SAMPLE COLLECTION FIELD SHEET

Project Name: Facility at 3200 Main, Keokuk, IAProject Number: 16530531.01001Sample Number: MW-23B-2011Personnel: CA/DKWell: MW-23BQA/QC Sample Yes No

Water Level Measurement

Depth to Water, From Top of Riser Pipe (ft): 2.03WL Date: 6-7-11WL Time: 11:12

Well Development/Purging

Date: 6-7-11Top of Screen (ft TOC) 22.60Bottom of Screen (ft TOC) 32.60Well Depth, Constructed (ft) 34.30Well Depth, Sounded (ft): Pump Depth (ft TOC): 30Method/Pump Type: Bladder PumpWater Level w/ Pump in (ft) (before): 1.33 (after): 3.28Casing Diameter (in): 2

Well volume above pump intake:

$$[(\text{ ft} \times 0.78\text{gal/ft}) + (\text{ ft} - \text{ ft})] \times 0.17\text{ft/gal} = \text{ gal} \times \text{ L/gal} = \text{ L}$$

System Volume = pump capacity + tubing + flow thru cell + sample bottles:

$$0.5\text{L} + (\text{ ft} \times 0.022\text{L/ft}) + 0.5\text{L} + 2.6\text{L} = \text{ L}$$

Time	1200	1205	1210	1215	1220	1225	1230	1235	1240	1245	
Temperature (°C)	19.12	19.10	19.21	19.05	19.02	18.79	18.88	18.69	18.71	18.64	18.63
Conduct (mmhos/cm)	2.038	2.035	2.039	2.029	2.025	2.001	1.931	1.754	1.945	1.930	1.922
pH	6.81	6.78	6.79	6.79	6.77	6.74	6.78	6.76	6.78	6.77	6.77
D.O. (mg/l)	0.87	0.80	0.63	0.50	0.45	0.38	0.35	0.32	0.29	0.27	0.24
ORP (mv)	44.7	40.8	50.1	50.3	53.0	55.2	55.1	55.8	55.6	56.2	57.9
Turbidity (NTU)	56.6	54.0	51.5	46.7	40.7	32.6	24.1	20.2	17.9	15.9	13.2
Water Level (ft)	3.10	3.12	3.13	3.13	3.16	3.22	3.22	3.28	3.29	3.28	3.28
Pump Rate (L/min)	150	150	150	150	150	150	150	150	150	150	150
Volume (L)	0.5	1.5	2.0	3.5	4.0	5.0	6.0	7	8	9	10

Sampling

Date: 6-7-11 Time: 1250 Method: Bladder Pump1300

Analyte	Method	Container	Preservation	Lab
VOC	SW846 8260B	3 x 40 ml vial	HCL	Accutest
MEE	RSK 175	3 x 40 ml vial	HCL	Accutest
TOC	9060	2 x 40 ml vial	HCL	Accutest
Sulfide	376.1	1 x 250 ml plastic	zinc acetate, sodium hydroxide	Accutest
Chl, SO4	300	1 x 250 ml plastic	4° C	Accutest
Diss Fe, Mn	6010B	1 x 500 ml plastic	4° C	Accutest
NO2, NO3, Alk	354.1, 353.2, 310.1	1 x 500 ml plastic	4° C	Accutest

Notes:

**FORMER SELLER-GLOBE FACILITY
3200 MAIN STREET, KEOKUK, IA
2011 GW MONITORING
DATA VERIFICATION REPORT**

Laboratory: Accutest
Data Package Numbers: T78000
Reviewer: Wendy Buchman
Peer Reviewer: Sheri Fling
Date Review Completed: July 28, 2011

This review was conducted in accordance with the Quality Assurance Project Plan (QAPP) for the Facility at 3200 Main Street Keokuk, Iowa (URSGWC, July 1999). Six aqueous samples were submitted for analysis. The review consisted of evaluation of sample-specific criteria for volatile organic compounds (VOCs) as described in the QAPP. Quality Control (QC) limits specified in the QAPP were utilized as guidance during VOC data validation; however laboratory derived limits were used to evaluate performance for the purpose of adding qualifiers for all parameters as these were not given in the QAPP. Guidelines from EPA Contract Laboratory Program (CLP) National Functional Guidelines for Organic and Inorganic Data Review and the analytical method specifications were used as guidance during data validation. If the QAPP, analytical method, and Functional Guidelines did not specify requirements related to the criterion under evaluation, the data reviewer utilized professional judgment to evaluate the effect of the reported item or condition on the associated analytical data. All uses of professional judgment are described in the data validation review narrative. The scope of the review has included evaluation of the sample management process, blank information, QA/QC results, and assessment of any laboratory parameter issues identified in the data package case narrative. The scope of the review did not include a detailed review of calibration information, compound identification or quantification, or checking for transcription or calculation errors. The following analytical reference methods were used:

Analytical Reference Method	Analysis
SW846 Method 8260B	VOCs
RSK-175	Methane, Ethane and Ethene
SW846 Method 6010B	Dissolved metals, Iron and Magnesium*
EPA 300.0/9056	Chloride and Sulfate
EPA 353.2	Nitrate and Nitrite
SM 2320B	Alkalinity
SM 4500S+F	Sulfide
SM 5310B	TOC

SW846 - Test Methods for Evaluating Solid Waste, Physical/Chemical Methods

SM - Standard Method

EPA - Environmental Protection Agency

TOC - Total Organic Carbon

* - All samples for dissolved iron and magnesium were filtered in the laboratory

Table 1 lists the samples reported in this data package. Table 2 presents the results of the review of sample-specific parameters and the associated details. If review of any laboratory parameters was necessary, the associated details are included in Table 2.

Table 1 – Sample Identification and Analysis Cross-Reference

Field ID	Lab ID	Sampling Date	QC Designations
MW-16-2011	T78000-1	06/07/2011	SA
MW-16-2011 Filtered	T78000-1F	06/07/2011	SA
MW-17A-2011	T78000-2	06/07/2011	SA
MW-17A-2011 Filtered	T78000-2F	06/07/2011	SA
MW-17B-2011	T78000-3	06/07/2011	SA
MW-17B-2011 Filtered	T78000-3F	06/07/2011	SA
MW-17B-2011-DUP	T78000-4	06/07/2011	FD
MW-17B-2011-DUP Filtered	T78000-4F	06/07/2011	FD
MW-23A-2011	T78000-5	06/07/2011	SA
MW-23A-2011 Filtered	T78000-5F	06/07/2011	SA
MW-23B-2011	T78000-6	06/07/2011	SA
MW-23B-2011 Filtered	T78000-6F	06/07/2011	SA
EB-23B-2011	T78000-7	06/07/2011	EB
Trip Blank	T78000-8	06/07/2011	TB
Trip Blank	T78000-9	06/07/2011	TB

SA = Sample
TB = Trip Blank

FD = Field duplicate
EB = Equipment Blank

MS = Matrix Spike

MSD = Matrix Spike Duplicate

General Usability Statement:

- ☐ Data are usable without qualification.
- ☒ Data are usable with qualification (noted below).
- ☐ Some or all data are unusable for any purpose (detailed below).

Case Narrative Summary: The laboratory case narrative indicated the following:

- **VOCs** – Methylene chloride was detected in the method blank. Several analytes were outside LCS laboratory control limits. Matrix spike, matrix spike duplicate and RPD recoveries for several analytes were outside laboratory control limits.
- **TOC** – The matrix spike recovery for TOC was outside control limits. The laboratory duplicate for TOC was outside of laboratory control limits.

Table 2 – Sample Specific Data Review Summary

Review Parameters	QAPP Criteria Met?	Comments
Accuracy Evaluation		
Method blanks?	Yes	Methylene chloride was found in the VOC method blank at 0.65 ug/L. After accounting for method blank contamination, methylene chloride was not found in the trip blanks. Methylene chloride was not detected in associated samples; therefore, qualification of data was not required.

Review Parameters	QAPP Criteria Met?	Comments										
Surrogate recoveries?	Yes	Laboratory-derived acceptance criteria were used by the laboratory to evaluate VOC surrogate recoveries rather than the acceptance range presented in the QAPP (76-115%) since the laboratory-derived limits were tighter. However, all surrogate recoveries were within laboratory-derived and QAPP acceptance criteria.										
LCS recoveries?	Yes	All recoveries were within 56-145% for VOCs as specified in the QAPP or within laboratory control limits for all other parameters.										
Matrix spike recoveries?	No	<p>The associated QAPP provided MS/MSD acceptance criteria for VOCs. All other parameters were evaluated using laboratory acceptance criteria.</p> <p><u>VOCs</u> MW-16-2011 The MS/MSD recoveries and RPDs for VOCs met QAPP (56-145% and <20% RPD) and laboratory quality control criteria, with the exception of the analytes listed in the table below.</p> <table><tr><th>Analyte</th><th>MS % R</th><th>MSD % R</th><th>RPD</th><th>QAPP Limits</th></tr><tr><td>Hexane</td><td>161¹</td><td>102</td><td>45¹</td><td>56-145/20</td></tr></table> <p>R = Recovery % = Percent RPD = Relative Percent Difference ¹ Recoveries outside QAPP acceptance limits.</p> <p>All MS/MSD and RPDs were within QAPP quality control criteria with the exception of the MS and RPD recoveries for hexane. Data qualification was considered necessary for the non-detect result for hexane due to outlying precision. Hexane in sample MW-16-2011 was UJ qualified as estimated.</p> <p><u>Dissolved Metals</u> MW-16-2011 Filtered The MS/MSD recovery for metals analysis met laboratory quality control criteria.</p> <p><u>Inorganics and Dissolved Gases</u> A MS/MSD was not analyzed for methane, ethane, ethene, alkalinity, chloride, nitrogen-nitrate, sulfate, and sulfide from a site specific sample. A site specific MS/MSD evaluation for these parameters can be found in the data validation report for SDG T78142. MS/MSD samples were collected at the QAPP required frequency of 1:20 samples. The non-site specific MS/MSDs reported in this data package were not used to assess matrix performance, per the QAPP the samples affected by MS/MSD recoveries outside evaluation criteria are the MS analytes in the parent sample and field duplicate only.</p> <p><u>TOC</u> MW-17B-2011 The MS recovery for TOC met laboratory quality control</p>	Analyte	MS % R	MSD % R	RPD	QAPP Limits	Hexane	161 ¹	102	45 ¹	56-145/20
Analyte	MS % R	MSD % R	RPD	QAPP Limits								
Hexane	161 ¹	102	45 ¹	56-145/20								

Review Parameters	QAPP Criteria Met?	Comments
		criteria.
Serial Dilution	Yes	The difference between the original and serial dilution for iron (0.5%) and manganese (1.5%) met laboratory acceptance criteria ($\pm 10\%$).
Trip Blank Evaluation?	Yes	After accounting for method blank contamination the trip blanks were free from detectable contamination.
Equipment Blank Evaluation?	Yes	The equipment blank was free from detectable contamination.
Precision Evaluation		
Laboratory duplicate criteria met?	Yes	<p>The laboratory performed a duplicate analysis for TOC using sample MW-17B-2011.</p> <p>The laboratory performed a duplicate analysis for dissolved iron and dissolved manganese using sample MW-16-2011 Filtered.</p> <p>All RPDs for duplicate measurements (regular laboratory duplicates and spiked duplicates) were within acceptance criteria.</p>
Representativeness Evaluation		
Analyses completed within holding time limits?	Yes	All samples were analyzed within the holding time requirements.
Were sample preservation requirements met?	Yes	
Field duplicate evaluation criteria met? • MW-17B-2011-DUP	Yes	
Comparability Evaluation		
Are accuracy criteria met?	Yes	This was evaluated using the LCS, MS/MSD and surrogate recoveries. In general, acceptable accuracy was attained with respect to the analytical method and sample matrix.
Are precision criteria met?	No	This was evaluated using the field duplicate pair and MS/MSD pairs. The MS and MSD results satisfied the precision evaluation criteria with the exception of one analyte. The analyte not meeting the acceptance limits was noted above. A data qualifier was assigned to reflect the potential imprecision in this result. For the field duplicate samples, precision criteria was met for all analytes.
Are measurement units and collection, analysis, and reporting methods consistent?	No	Sample analyses for 8260B and RSKSOP-147/175 are reported using mg/L. Laboratory QC samples are reported using ug/L. All other analyses have sample results and QC results reported in the same units.
Completeness Evaluation		
Sample receipt completeness?	No	The samples were received by Accutest in good condition and were consistent with the accompanying chain-of-custody form (COC) with two exceptions; the trip blanks were not listed on the COC. The trip blanks were analyzed by the laboratory and included in the sample results. The cooler temperatures upon receipt at the Accutest Houston laboratory were 5.1°C and 2.5°C; within the recommended (40 CFR Part 136) <6°C temperature. The cooler subcontracted for method RSK/147

Review Parameters	QAPP Criteria Met?	Comments
		methane, ethane and ethane analysis at the Accutest Florida laboratory was 4.0°C.
Were results received for all samples?	Yes	
Are any data qualified as unusable?	No	
Sensitivity Evaluation		
Were project-required RLs obtained?	Yes	There are no instances of non-detectable results with elevated reporting limits in this data set. Detectable concentrations were reported for all results reported from dilutions.
Review of Laboratory Performance Parameters		
Instrument tuning?	NR	
Initial calibration?	NR	
Continuing calibration?	NR	
Compound identification?	NR	
Compound quantitation?	NR	
TIC evaluation?	NA	
Laboratory assigned qualifiers?	Yes	

NA = Not Applicable

VOC = Volatile Organic Compounds

mg/L = milligrams per Liter

C = Celsius

MS = Matrix Spike

COC = Chain of Custody

QA = Quality Assurance

NR = Not Required

TOC = Total Organic Carbon

% = Percent

UJ = Estimated nondetect

MSD = Matrix Spike Duplicate

RL = Reporting Limit

SDG = Sample Delivery Group

QAPP = Quality Assurance Project Plan

ug/L = micrograms per Liter

<= Less than

RPD = Relative Percent Difference

LCS = Laboratory Control Sample

QC = Quality Control

Limitations on Data Usability: Trace level detections, reported between the method detection limit (MDL) and the reporting limit (RL) have been qualified as estimated (J).

**FORMER SELLER-GLOBE FACILITY
3200 MAIN STREET, KEOKUK, IA
2011 GW MONITORING
DATA VERIFICATION REPORT**

Laboratory: Accutest
Data Package Numbers: T78142
Reviewer: Wendy Buchman
Peer Reviewer: Sheri Fling
Date Review Completed: July 28, 2011

This review was conducted in accordance with the Quality Assurance Project Plan (QAPP) for the Facility at 3200 Main Street Keokuk, Iowa (URSGWC, July 1999). Nineteen aqueous samples were submitted for analysis. The review consisted of evaluation of sample-specific criteria for volatile organic compounds (VOCs) as described in the QAPP. Quality Control (QC) limits specified in the QAPP were utilized as guidance during VOC data validation; however laboratory derived limits were used to evaluate performance for the purpose of adding qualifiers for all parameters as these were not given in the QAPP. Guidelines from EPA Contract Laboratory Program (CLP) National Functional Guidelines for Organic and Inorganic Data Review and the analytical method specifications were used as guidance during data validation. If the QAPP, analytical method, and Functional Guidelines did not specify requirements related to the criterion under evaluation, the data reviewer utilized professional judgment to evaluate the effect of the reported item or condition on the associated analytical data. All uses of professional judgment are described in the data validation review narrative. The scope of the review has included evaluation of the sample management process, blank information, QA/QC results, and assessment of any laboratory parameter issues identified in the data package case narrative. The scope of the review did not include a detailed review of calibration information, compound identification or quantification, or checking for transcription or calculation errors. The following analytical reference methods were used:

Analytical Reference Method	Analysis
SW846 Method 8260B	VOCs
RSK-175	Methane, Ethane and Ethene
SW846 Method 6010B	Dissolved metals, Iron and Magnesium*
EPA 300.0/9056	Chloride and Sulfate
EPA 353.2	Nitrate and Nitrite
SM 2320B	Alkalinity
SM 4500S+F	Sulfide
SM 5310B	TOC

SW846 - Test Methods for Evaluating Solid Waste, Physical/Chemical Methods

SM - Standard Method

EPA - Environmental Protection Agency

TOC - Total Organic Carbon

* - All samples for dissolved iron and magnesium were filtered in the laboratory

Table 1 lists the samples reported in this data package. Table 2 presents the results of the review of sample-specific parameters and the associated details. If review of any laboratory parameters was necessary, the associated details are included in Table 2.

Table 1 – Sample Identification and Analysis Cross-Reference

Field ID	Lab ID	Sampling Date	QC Designations
MW-19-2011	T78142-1	06/08/2011	SA
MW-19-2011 (MSD)	T78142-1D	06/08/2011	MSD
MW-19-2011 (MSD) Filtered	T78142-1DF	06/08/2011	MSD Filtered
MW-19-2011 Filtered	T78142-1F	06/08/2011	SA
MW-19-2011 (MS)	T78142-1S	06/08/2011	MS
MW-19-2011 (MS) Filtered	T78142-1SF	06/08/2011	MS Filtered
MW-20-2011	T78142-2	06/08/2011	SA
MW-20-2011 Filtered	T78142-2F	06/08/2011	SA
MW-3-2011	T78142-3	06/08/2011	SA
MW-3-2011 Filtered	T78142-3F	06/08/2011	SA
MW-1-2011	T78142-4	06/08/2011	SA
MW-1-2011 Filtered	T78142-4F	06/08/2011	SA
MW-6A-2011	T78142-5	06/08/2011	SA
MW-6A-2011 Filtered	T78142-5F	06/08/2011	SA
MW-2R-2011	T78142-6	06/08/2011	SA
MW-2R-2011 Filtered	T78142-6F	06/08/2011	SA
MW-7-2011	T78142-7	06/08/2011	SA
MW-7-2011 Filtered	T78142-7F	06/08/2011	SA
EB-7-2011	T78142-8	06/08/2011	EB
MW-10-2011	T78142-9	06/08/2011	SA
MW-10-2011 Filtered	T78142-9F	06/08/2011	SA
MW-10A-2011	T78142-10	06/08/2011	SA
MW-10A-2011 Filtered	T78152-10F	06/08/2011	SA
TRIP BLANK 1	T78142-11	06/08/2011	TB
TRIP BLANK 2	T78142-12	06/08/2011	TB
TRIP BLANK 3	T78142-13	06/08/2011	TB
TRIP BLANK 4	T78142-14	06/08/2011	TB

SA = Sample
TB = Trip Blank

FD = Field duplicate
EB = Equipment Blank

MS = Matrix Spike

MSD = Matrix Spike Duplicate

General Usability Statement:

- ☐ Data are usable without qualification.
- ☒ Data are usable with qualification (noted below).
- ☐ Some or all data are unusable for any purpose (detailed below).

Case Narrative Summary: The laboratory case narrative indicated the following:

- **VOCs** – Methylene chloride was detected in the method blank. Several analytes were outside LCS laboratory control limits.
- **Dissolved Gas** – The matrix spike, matrix spike duplicate and RPD recoveries for ethane, ethene and methane were outside laboratory control limits.

Table 2 – Sample Specific Data Review Summary

Review Parameters	QAPP Criteria Met?	Comments
Accuracy Evaluation		
Method blanks?	Yes	Methylene chloride was found in the VOC method blank at 0.65 ug/L. Methylene chloride was not detected in associated samples; therefore, qualification of data was not required.
Surrogate recoveries?	Yes	Laboratory-derived acceptance criteria were used by the laboratory to evaluate VOC surrogate recoveries rather than the acceptance range presented in the QAPP (76-115%) since the laboratory-derived limits were tighter. However, all surrogate recoveries were within laboratory-derived and QAPP acceptance criteria.
LCS recoveries?	Yes	All recoveries were within 56-145% for VOCs as specified in the QAPP or within laboratory control limits for all other parameters.
Matrix spike recoveries?	No	<p>The associated QAPP provided MS/MSD acceptance criteria for VOCs. All other parameters were evaluated using laboratory acceptance criteria.</p> <p><u>VOCs</u> MW-19-2011 The MS/MSD recoveries and RPDs for VOCs met QAPP (56-145% and <20% RPD) and laboratory quality control criteria.</p> <p><u>Dissolved Metals</u> MW-19-2011 Filtered The MS/MSD recovery for metals analysis met laboratory quality control criteria.</p> <p><u>Inorganics</u> MW-19-2011 The MS/MSD recovery for alkalinity, choride, nitrogen nitrate, nitrogen nitrite, sulfate and sulfide met laboratory quality control criteria.</p> <p><u>TOC</u> MW-19-2011 The MS recovery for TOC met laboratory quality control criteria.</p> <p><u>Dissolved Gas</u> MW-19-2011 The MS recovery for dissolved gas analysis were outside laboratory control criteria are listed in the table below.</p>

Review Parameters	QAPP Criteria Met?	Comments												
		<table> <tr> <th>Analyte</th><th>MS % R</th><th>Lab Limits</th></tr> <tr> <td>Methane</td><td>152</td><td>54-149</td></tr> <tr> <td>Ethane</td><td>160</td><td>57-143</td></tr> <tr> <td>Ethene</td><td>161</td><td>57-143</td></tr> </table> <p>MS = Matrix Spike % = Percent R = Recovery</p> <p>The detected result for Methane in sample MW-19-2011 was J qualified as estimated due to possible high bias. Ethane and Ethene were non-detect.</p>	Analyte	MS % R	Lab Limits	Methane	152	54-149	Ethane	160	57-143	Ethene	161	57-143
Analyte	MS % R	Lab Limits												
Methane	152	54-149												
Ethane	160	57-143												
Ethene	161	57-143												
Serial Dilution	Yes	The difference between the original and serial dilution for iron (0.0%) and manganese (0.1%) met laboratory acceptance criteria ($\pm 10\%$).												
Trip Blank Evaluation?	Yes	The trip blank was free from detectable contamination.												
Equipment Blank Evaluation?	Yes	The equipment blank was free from detectable contamination.												
Precision Evaluation														
Laboratory duplicate criteria met?	Yes	<p>The laboratory performed a duplicate analysis for chloride, nitrogen nitrate, nitrogen nitrite, sulfate, sulfide and TOC using sample MW-19-2011.</p> <p>The laboratory performed a duplicate analysis for alkalinity using sample MW-3-2011.</p> <p>The laboratory performed a duplicate analysis for dissolved iron and dissolved manganese using sample MW-19-2011 Filtered.</p> <p>All RPDs for duplicate measurements (regular laboratory duplicates and spiked duplicates) were within acceptance criteria.</p>												
Representativeness Evaluation														
Analyses completed within holding time limits?	Yes	All samples were analyzed within the holding time requirements.												
Were sample preservation requirements met?	Yes													
Field duplicate evaluation criteria met?	NA	A field duplicate was not collected and reported in this SDG. However, field duplicates were collected and reported with other site SDGs and were analyzed at the QAPP-specified frequency.												
Comparability Evaluation														
Are accuracy criteria met ?	Yes	This was evaluated using the LCS, MS/MSD and surrogate recoveries. In general, acceptable accuracy was attained with respect to the analytical method and sample matrix.												
Are precision criteria met?	Yes	This was evaluated using the laboratory duplicate pairs and MS/MSD pairs. The laboratory duplicate pairs MS and MSD results satisfied the precision evaluation criteria.												

Review Parameters	QAPP Criteria Met?	Comments
Are measurement units and collection, analysis, and reporting methods consistent?	No	Sample analyses for 8260B and RSKSOP-147/175 are reported using mg/L. Laboratory QC samples are reported using ug/L. All other analyses have sample results and QC results reported in the same units.
Completeness Evaluation		
Sample receipt completeness?	No	The samples were received by Accutest in good condition and were consistent with the accompanying chain-of-custody form (COC) with two exceptions; samples MW-10-2011 and MW-10A-2011 did not have collection times listed on the COC. The laboratory used the time listed on the bottles when logging the samples in. Additionally, the trip blanks were not listed on the COC. The trip blanks were analyzed by the laboratory and included in the sample results. The cooler temperatures upon receipt at the Accutest Houston laboratory were 1.3°C, 1.0°C, 1.3°C and 2.1°C; within the recommended (40 CFR Part 136) <6°C temperature. The cooler subcontracted for method RSK/147 methane, ethane and ethane analysis at the Accutest Florida laboratory was 2.6°C.
Were results received for all samples?	Yes	
Are any data qualified as unusable?	No	
Sensitivity Evaluation		
Were project-required RLs obtained?	Yes	There are no instances of non-detectable results with elevated reporting limits in this data set. Detectable concentrations were reported for all results reported from dilutions.
Review of Laboratory Performance Parameters		
Instrument tuning?	NR	
Initial calibration?	NR	
Continuing calibration?	NR	
Compound identification?	NR	
Compound quantitation?	NR	
TIC evaluation?	NA	
Laboratory assigned qualifiers?	Yes	

NA = Not Applicable

VOC = Volatile Organic Compounds

mg/L = milligrams per Liter

C = Celsius

MS = Matrix Spike

COC = Chain of Custody

QA = Quality Assurance

NR = Not Required

TOC = Total Organic Carbon

% = Percent

UJ = Estimated nondetect

MSD = Matrix Spike Duplicate

RL = Reporting Limit

SDG = Sample Delivery Group

QAPP = Quality Assurance Project Plan

ug/L = micrograms per Liter

< = Less than

RPD = Relative Percent Difference

LCS = Laboratory Control Sample

QC = Quality Control

J = Estimated detected

Limitations on Data Usability: Trace level detections, reported between the method detection limit (MDL) and the reporting limit (RL) have been qualified as estimated (J).

**FORMER SHELLER-GLOBE FACILITY
3200 MAIN STREET, KEOKUK, IA
2011 GW MONITORING
DATA VERIFICATION REPORT**

Laboratory: Accutest
Data Package Numbers: T79594
Reviewer: Wendy Buchman
Peer Reviewer: Sheri Fling
Date Review Completed: July 28, 2011

This review was conducted in accordance with the Quality Assurance Project Plan (QAPP) for the Facility at 3200 Main Street Keokuk, Iowa (URSGWC, July 1999). Nine aqueous samples were submitted for analysis. The review consisted of evaluation of sample-specific criteria for volatile organic compounds (VOCs) as described in the QAPP. Quality Control (QC) limits specified in the QAPP were utilized as guidance during VOC data validation; however laboratory derived limits were used to evaluate performance for the purpose of adding qualifiers for all parameters as these were not given in the QAPP. Guidelines from EPA Contract Laboratory Program (CLP) National Functional Guidelines for Organic and Inorganic Data Review and the analytical method specifications were used as guidance during data validation. If the QAPP, analytical method, and Functional Guidelines did not specify requirements related to the criterion under evaluation, the data reviewer utilized professional judgment to evaluate the effect of the reported item or condition on the associated analytical data. All uses of professional judgment are described in the data validation review narrative. The scope of the review has included evaluation of the sample management process, blank information, QA/QC results, and assessment of any laboratory parameter issues identified in the data package case narrative. The scope of the review did not include a detailed review of calibration information, compound identification or quantification, or checking for transcription or calculation errors. The following analytical reference methods were used:

Analytical Reference Method	Analysis
SW846 Method 8260B	VOCs
RSK-175	Methane, Ethane and Ethene
SW846 Method 6010B	Dissolved metals, Iron and Magnesium*
EPA 300.0/9056	Chloride and Sulfate
EPA 353.2	Nitrate and Nitrite
SM 2320B	Alkalinity
SM 4500S+F	Sulfide
SM 5310B	TOC

SW846 - Test Methods for Evaluating Solid Waste, Physical/Chemical Methods

SM - Standard Method

EPA - Environmental Protection Agency

TOC - Total Organic Carbon

* - All samples for dissolved iron and magnesium were filtered in the laboratory

Table 1 lists the samples reported in this data package. Table 2 presents the results of the review of sample-specific parameters and the associated details. If review of any laboratory parameters was necessary, the associated details are included in Table 2.

Table 1 – Sample Identification and Analysis Cross-Reference

Field ID	Lab ID	Sampling Date	QC Designations
MW-13A-2011	T79594	06/23/2011	SA
MW-13A-2011 Filtered	T79594-1F	06/23/2011	SA
MW-13-2011	T79594-2	06/23/2011	SA
MW-13-2011 Filtered	T79594-2F	06/23/2011	SA
MW-13-2011-Dup	T79594-3	06/23/2011	FD
MW-13-2011-Dup Filtered	T79594-3F	06/23/2011	FD
MW-13B-2011	T79594-4	06/23/2011	SA
MW-13B-2011 Filtered	T79594-4F	06/23/2011	SA
EB-13B-2011	T79594-5	06/23/2011	EB
Trip Blank	T79594-6	06/23/2011	TB

SA = Sample
TB = Trip Blank

FD = Field duplicate
EB = Equipment Blank

MS = Matrix Spike

MSD = Matrix Spike Duplicate

General Usability Statement:

- ☒ Data are usable without qualification.
☐ Data are usable with qualification (noted below).
☐ Some or all data are unusable for any purpose (detailed below).

Case Narrative Summary: The laboratory case narrative indicated the following:

- VOCs –Several analytes were outside LCS laboratory control limits.

Table 2 – Sample Specific Data Review Summary

Review Parameters	QAPP Criteria Met?	Comments
Accuracy Evaluation		
Method blanks?	Yes	The method blank was free from detectable contamination.
Surrogate recoveries?	Yes	Laboratory-derived acceptance criteria were used by the laboratory to evaluate VOC surrogate recoveries rather than the acceptance range presented in the QAPP (76-115%). All surrogate recoveries were within laboratory-derived and QAPP acceptance criteria.
LCS recoveries?	Yes	All recoveries were within 56-145% for VOCs as specified in the QAPP or within laboratory control limits for all other parameters.
Matrix spike recoveries?	NA	The associated QAPP provided MS/MSD acceptance criteria for VOCs. All other parameters were evaluated using laboratory acceptance criteria, however a site specific MS/MSD was not analyzed for parameters analyzed in this SDG. A site specific MS/MSD evaluation for these parameters can be found in the data validation report for SDG T78142. MS/MSD samples were collected at the QAPP required frequency of 1:20 samples. The

Review Parameters	QAPP Criteria Met?	Comments
		non-site specific MS/MSDs reported in this data package were not used to assess matrix performance, per the QAPP the samples affected by MS/MSD recoveries outside evaluation criteria are the MS analytes in the parent sample and field duplicate only.
Serial Dilution	Yes	The difference between the original and serial dilution for iron (8.7%) and manganese (0.5%) met laboratory acceptance criteria ($\pm 10\%$).
Trip Blank Evaluation?	Yes	The trip blank contained 0.0120 mg/L acetone. Acetone was not detected in the associated samples. Qualification of data was not required.
Equipment Blank Evaluation?	Yes	The equipment blank was free from detectable contamination.
Precision Evaluation		
Laboratory duplicate criteria met?	Yes	The laboratory performed a duplicate analysis for chloride, nitrogen nitrate, nitrogen nitrite and sulfate using sample MW-13-2011. All RPDs for duplicate measurements (regular laboratory duplicates and spiked duplicates) were within acceptance criteria.
Representativeness Evaluation		
Analyses completed within holding time limits?	Yes	All samples were analyzed within the holding time requirements.
Were sample preservation requirements met?	Yes	
Field duplicate evaluation criteria met?	NA	A field duplicate was not collected and reported in this SDG. However, field duplicates were collected and reported with other site SDGs and were analyzed at the QAPP-specified frequency.
Comparability Evaluation		
Are accuracy criteria met?	Yes	This was evaluated using the LCS and surrogate recoveries. In general, acceptable accuracy was attained with respect to the analytical method and sample matrix.
Are precision criteria met?	Yes	This was evaluated using the laboratory duplicate pairs. The laboratory duplicate pairs satisfied the precision evaluation criteria.
Are measurement units and collection, analysis, and reporting methods consistent?	No	Sample analyses for 8260B and RSKSOP-147/175 are reported using mg/L. Laboratory QC samples are reported using ug/L. All other analyses have sample results and QC results reported in the same units.
Completeness Evaluation		
Sample receipt completeness?	Yes	The samples were received by Accutest in good condition and were consistent with the accompanying chain-of-custody form (COC). The cooler temperature upon receipt at the Accutest Houston laboratory was 0.7°C; within the recommended (40 CFR Part 136) <6°C temperature. The cooler subcontracted for method RSK/147 methane, ethane and ethane analysis at the Accutest Florida laboratory was 2.8°C.
Were results received for all samples?	Yes	

Review Parameters	QAPP Criteria Met?	Comments
Are any data qualified as unusable?	No	
Sensitivity Evaluation		
Were project-required RLs obtained?	Yes	There are no instances of non-detectable results with elevated reporting limits in this data set. Detectable concentrations were reported for all results reported from dilutions.
Review of Laboratory Performance Parameters		
Instrument tuning?	NR	
Initial calibration?	NR	
Continuing calibration?	NR	
Compound identification?	NR	
Compound quantitation?	NR	
TIC evaluation?	NA	
Laboratory assigned qualifiers?	Yes	

NA = Not Applicable

VOC = Volatile Organic Compounds

mg/L = milligrams per Liter

C = Celsius

MS = Matrix Spike

COC = Chain of Custody

QA = Quality Assurance

NR = Not Required

TOC = Total Organic Carbon

% = Percent

RPD = Relative Percent Difference

MSD = Matrix Spike Duplicate

RL = Reporting Limit

SDG = Sample Delivery Group

QAPP = Quality Assurance Project Plan

ug/L = micrograms per Liter

< = Less than

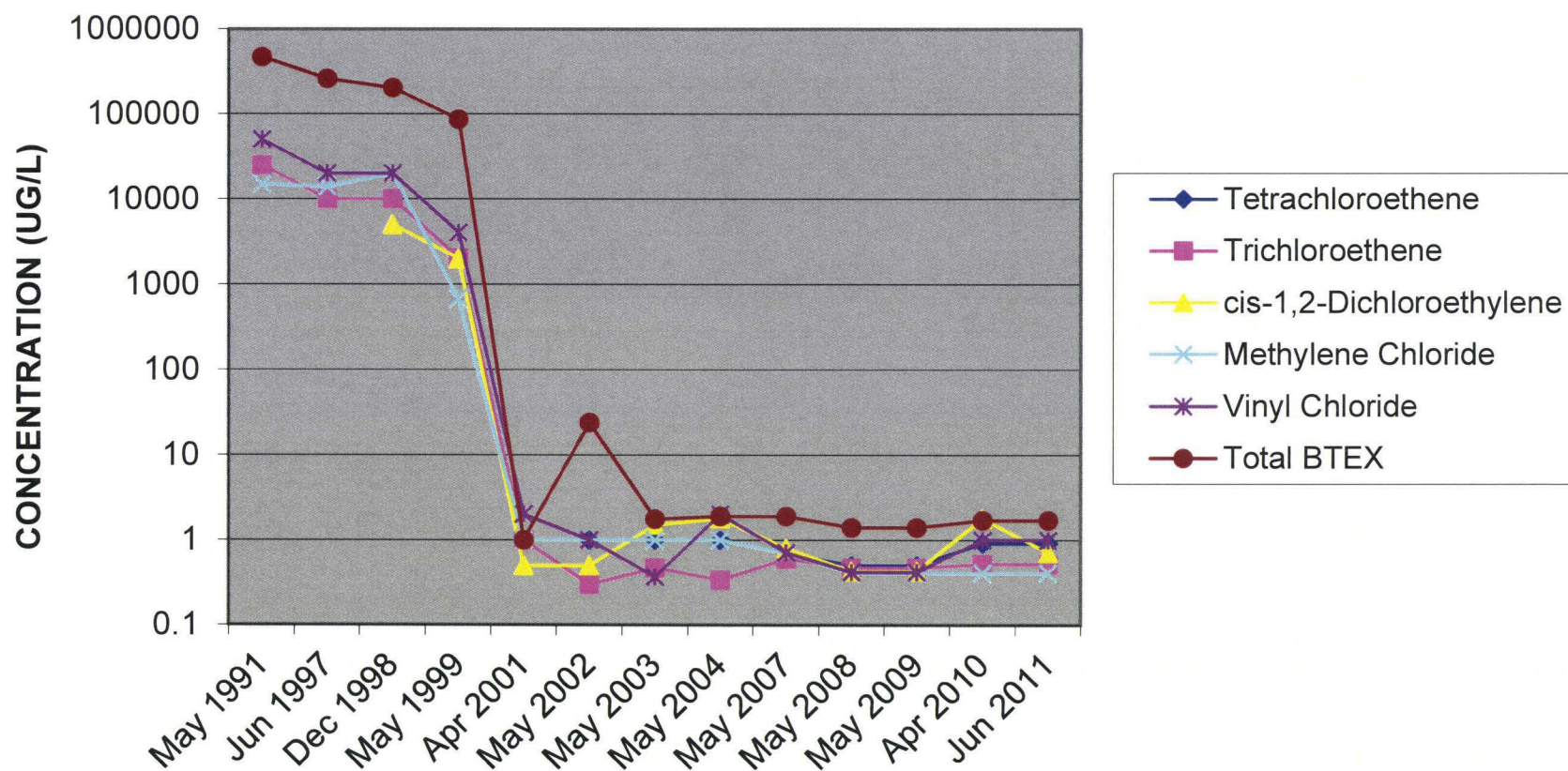
SDG = Sample Delivery Group

LCS = Laboratory Control Sample

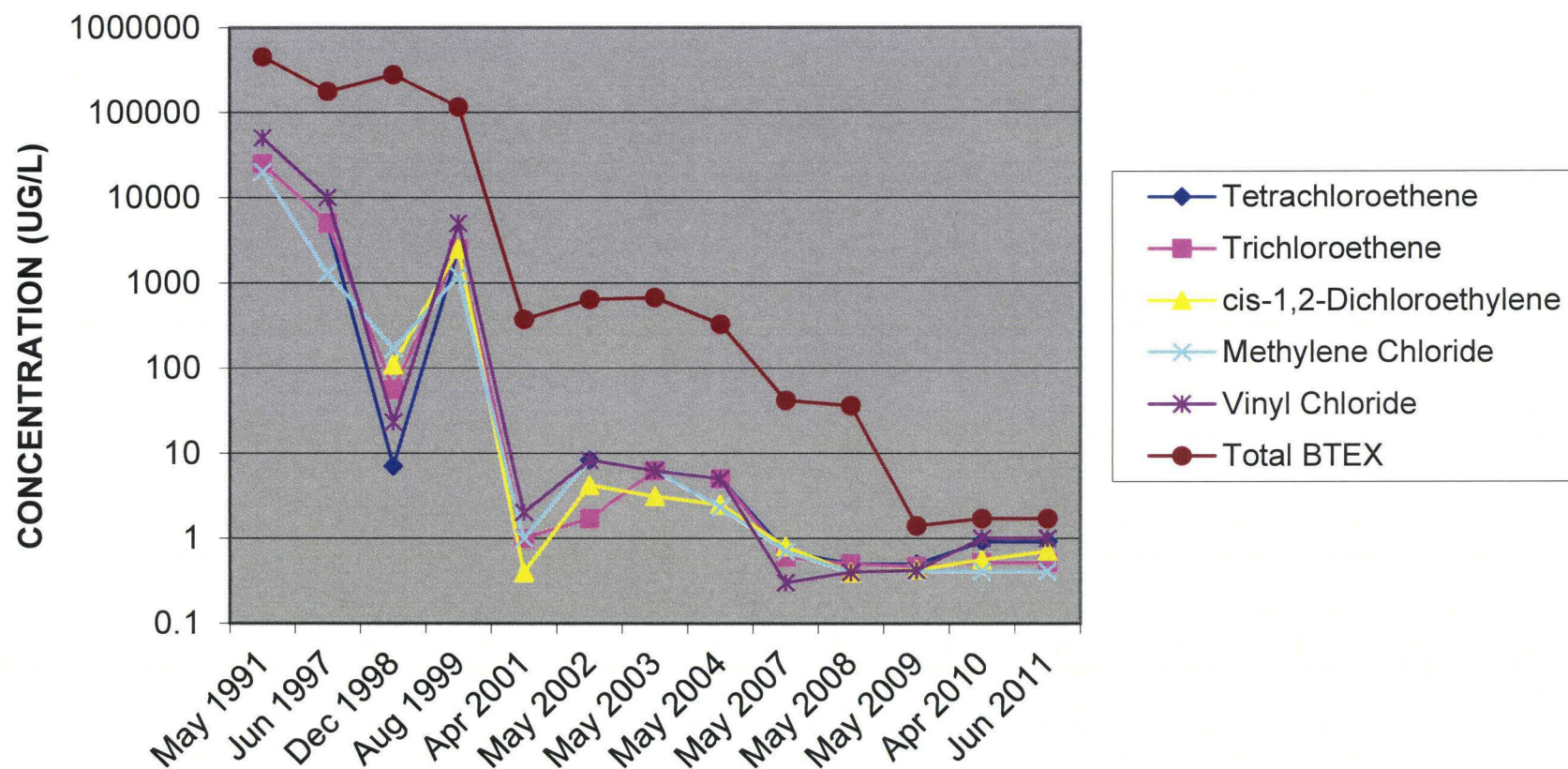
QC = Quality Control

Limitations on Data Usability: Trace level detections, reported between the method detection limit (MDL) and the reporting limit (RL) have been qualified as estimated (J).

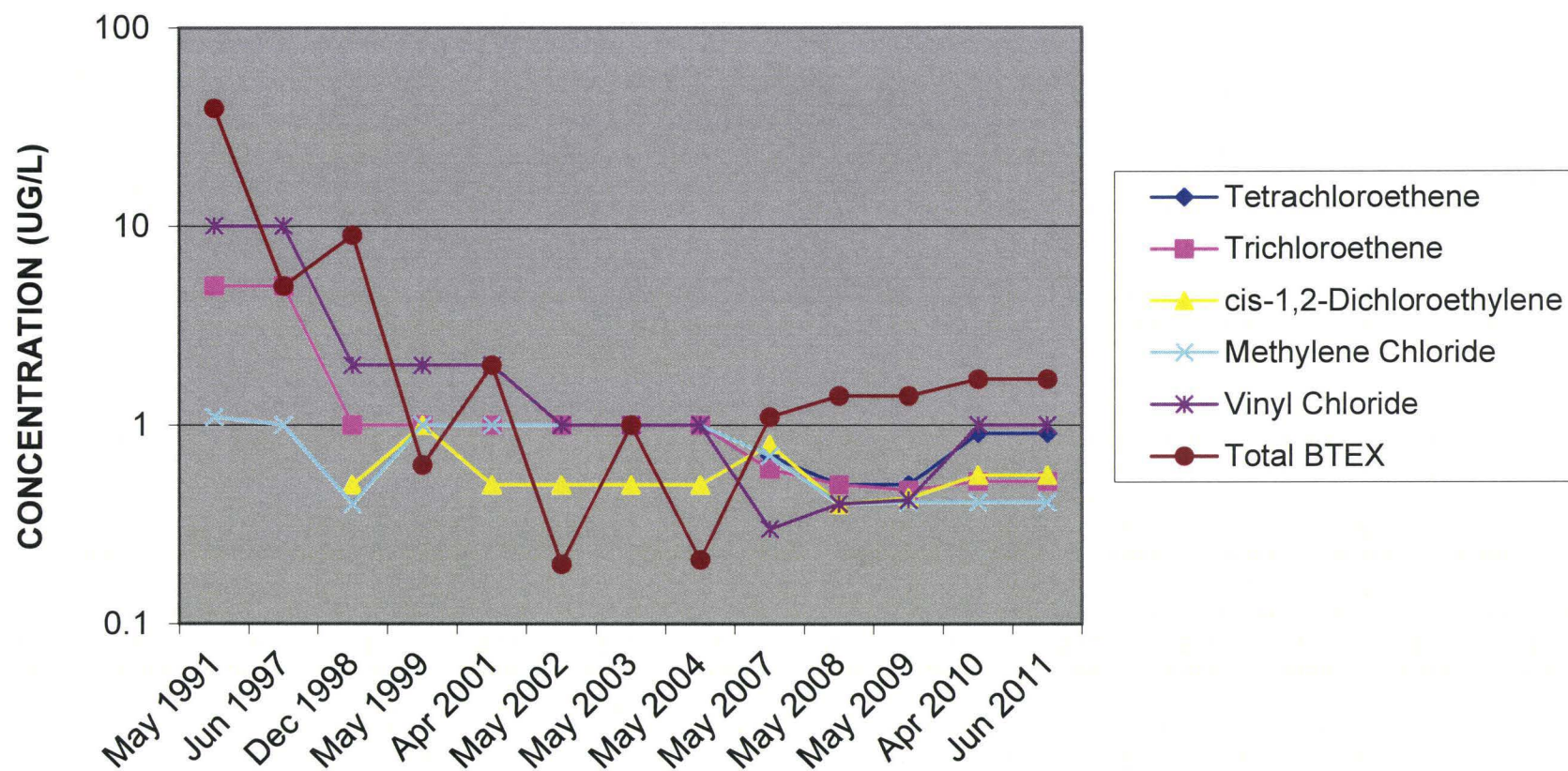
CONCENTRATIONS VS TIME IN MONITORING WELL MW-1



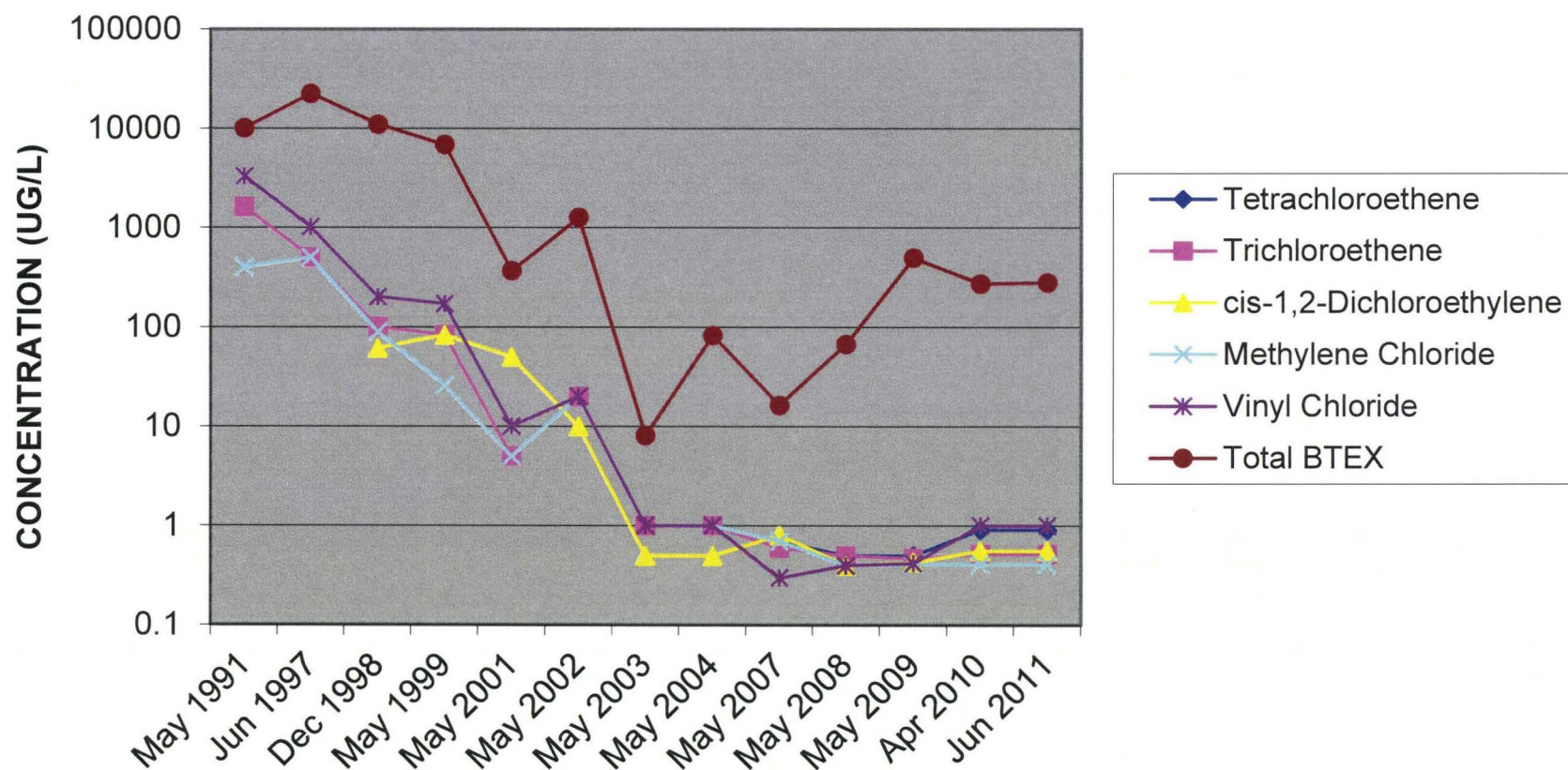
CONCENTRATIONS VS TIME IN MONITORING WELL MW-2



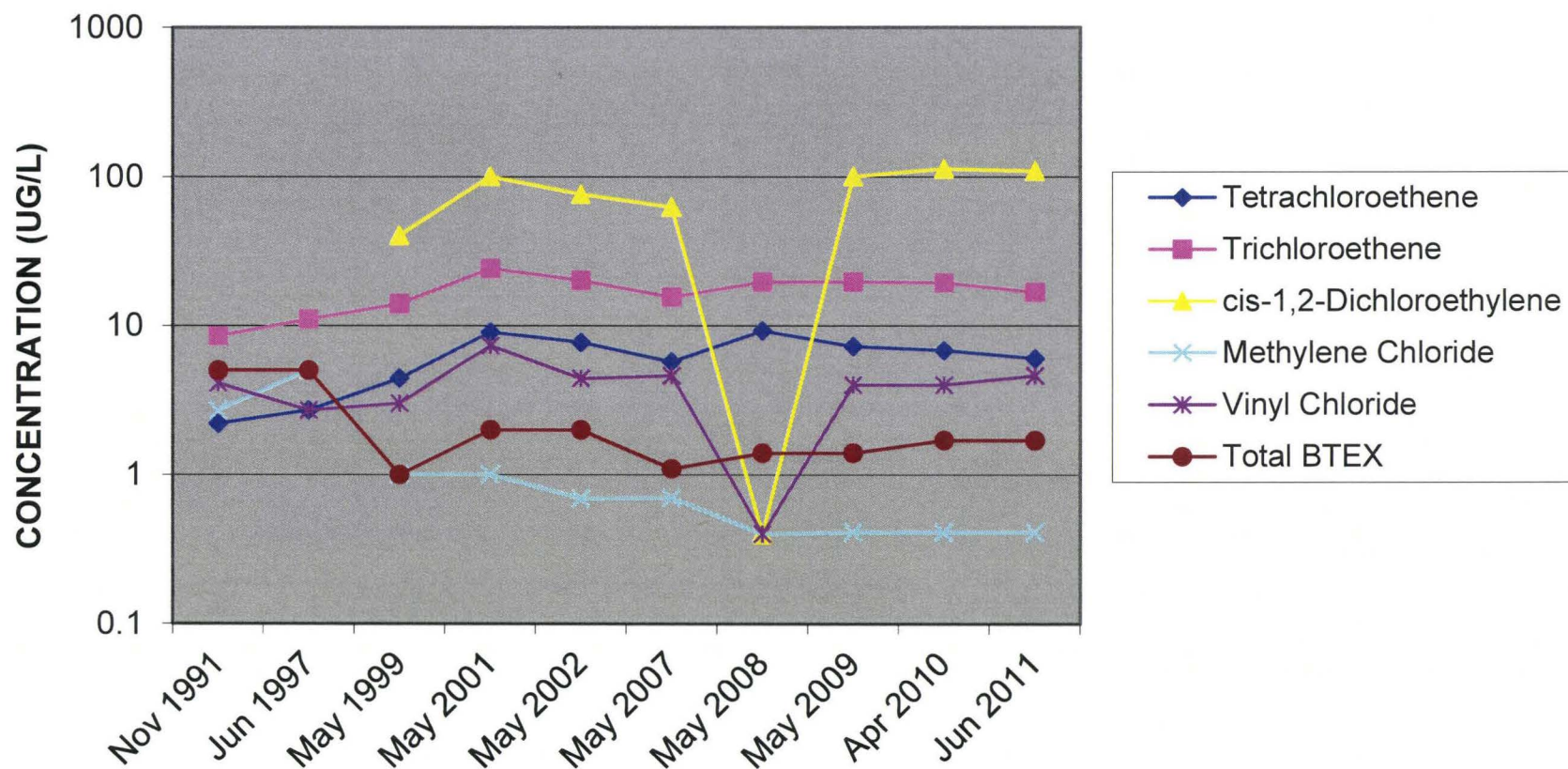
CONCENTRATIONS VS TIME IN MONITORING WELL MW-3



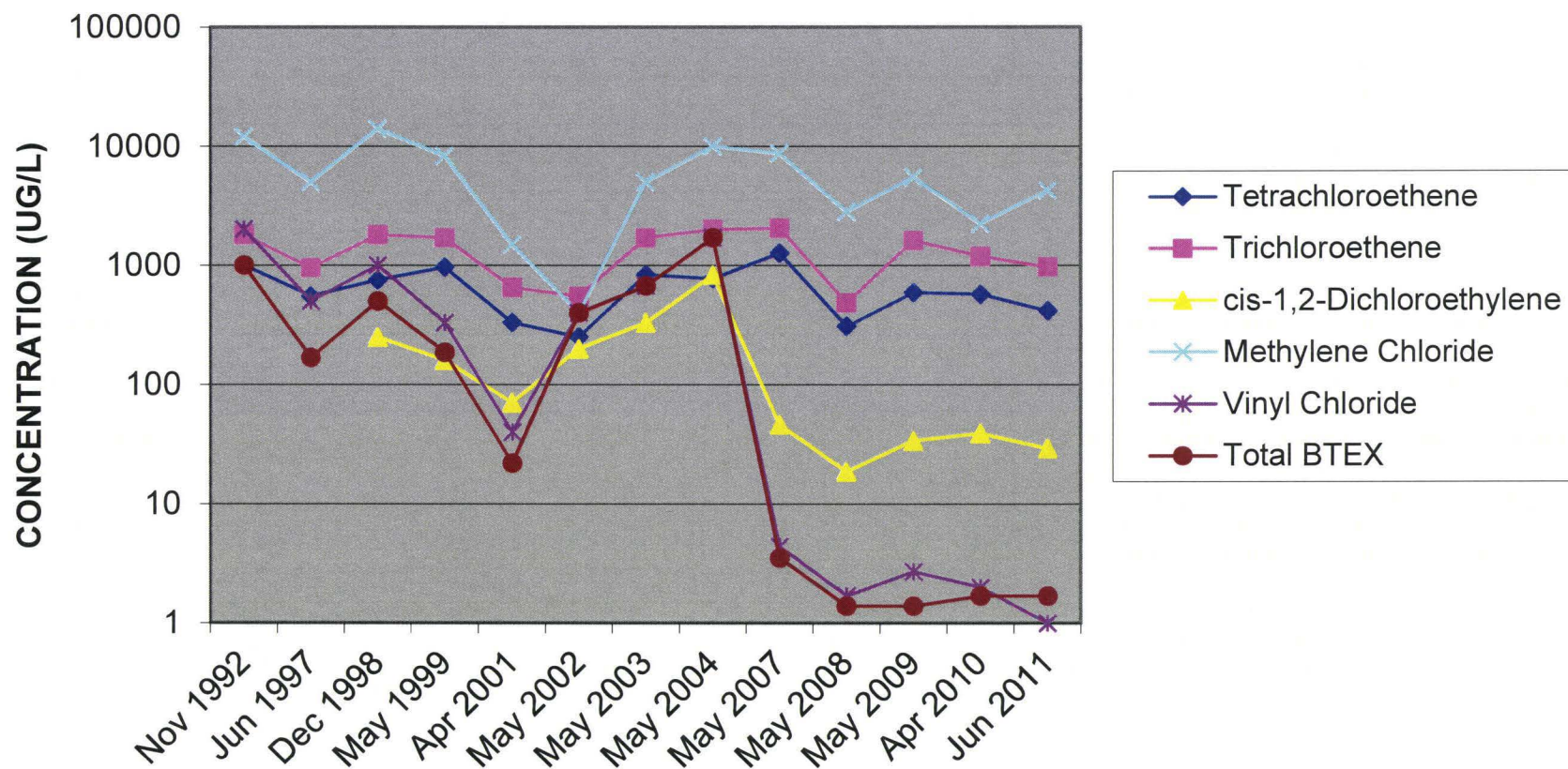
CONCENTRATIONS VS TIME IN MONITORING WELL MW-6A



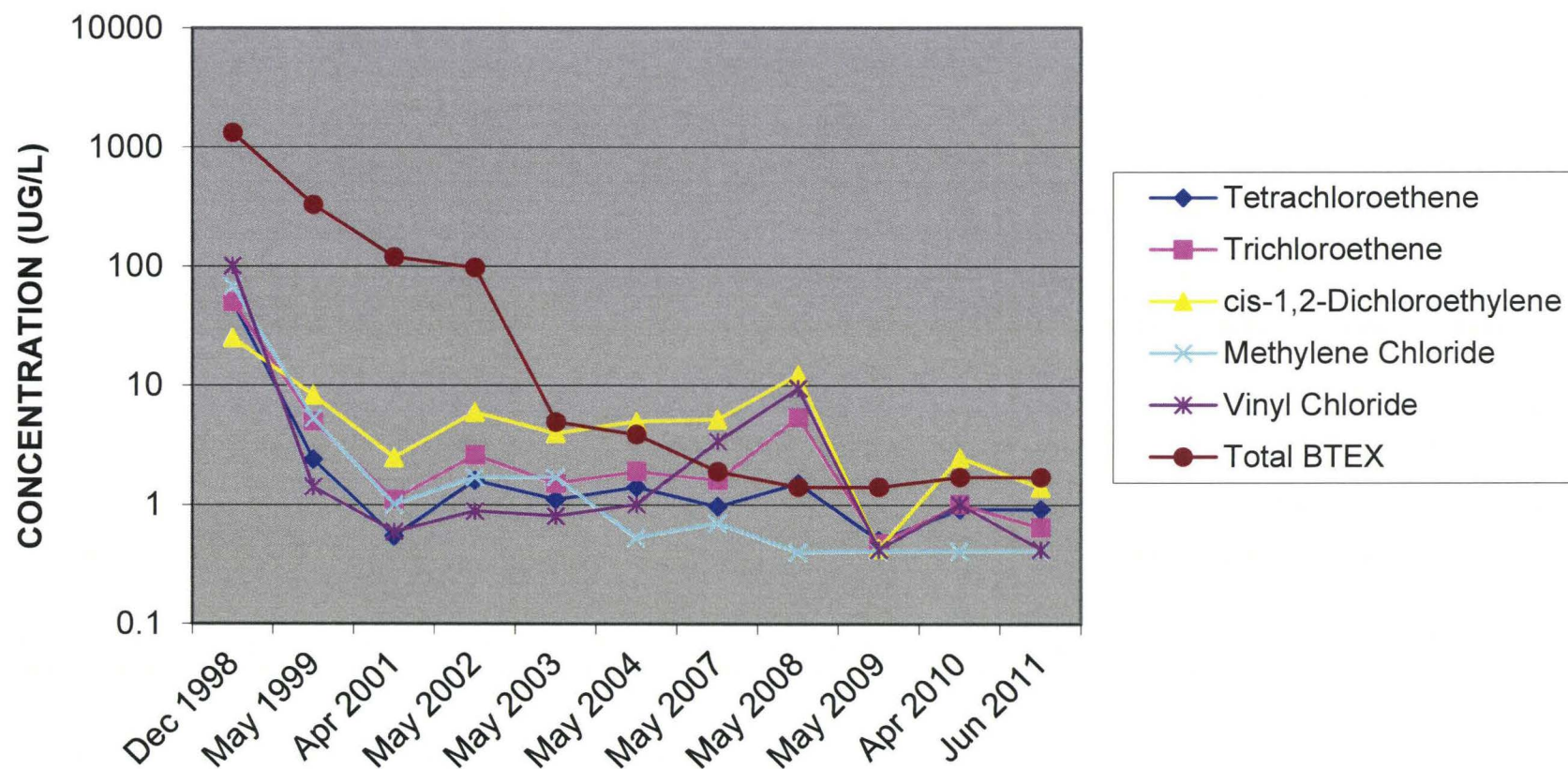
CONCENTRATIONS VS TIME IN MONITORING WELL MW-7



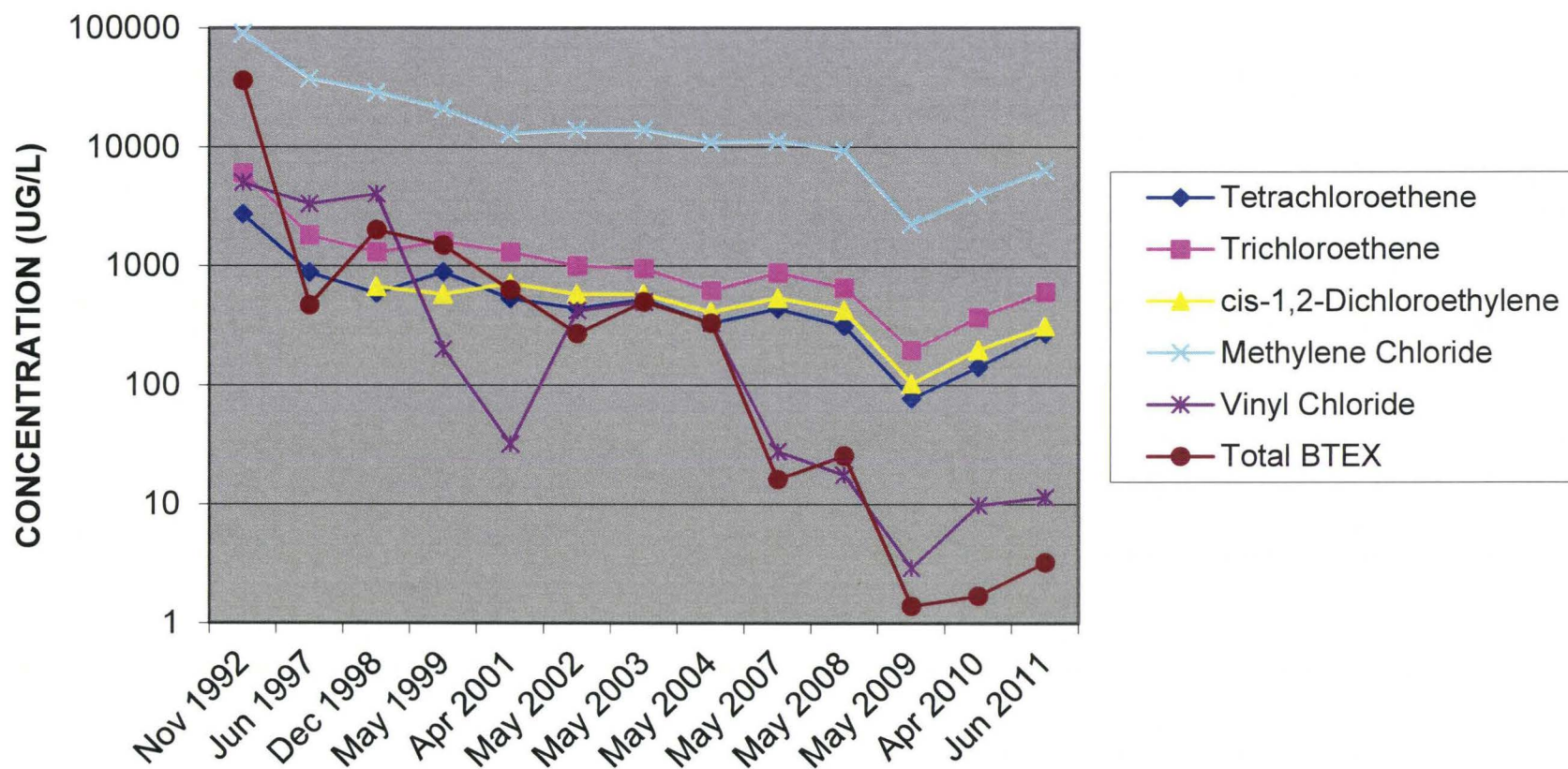
CONCENTRATIONS VS TIME IN MONITORING WELL MW-10



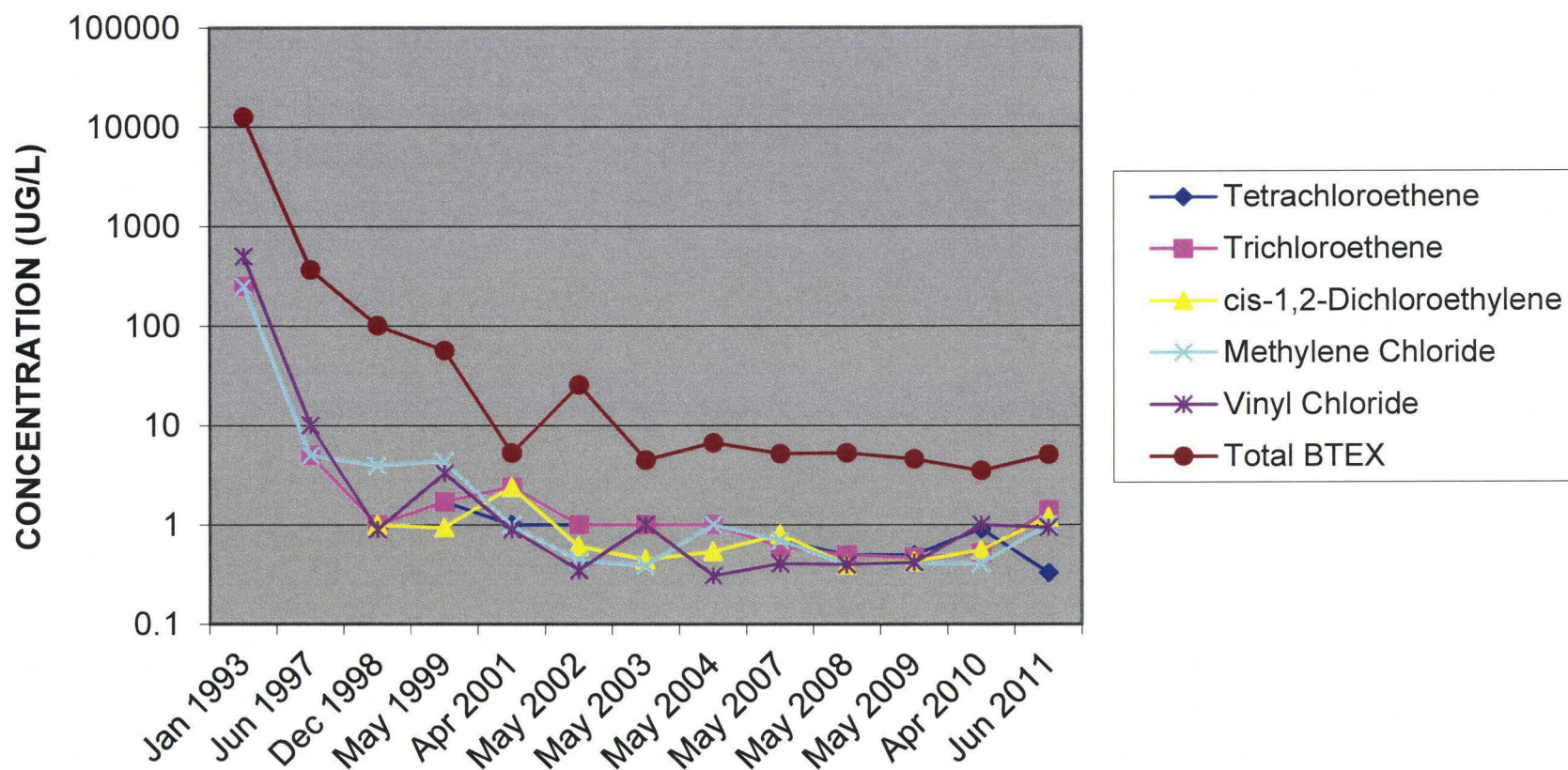
CONCENTRATIONS VS TIME IN MONITORING WELL MW-10A



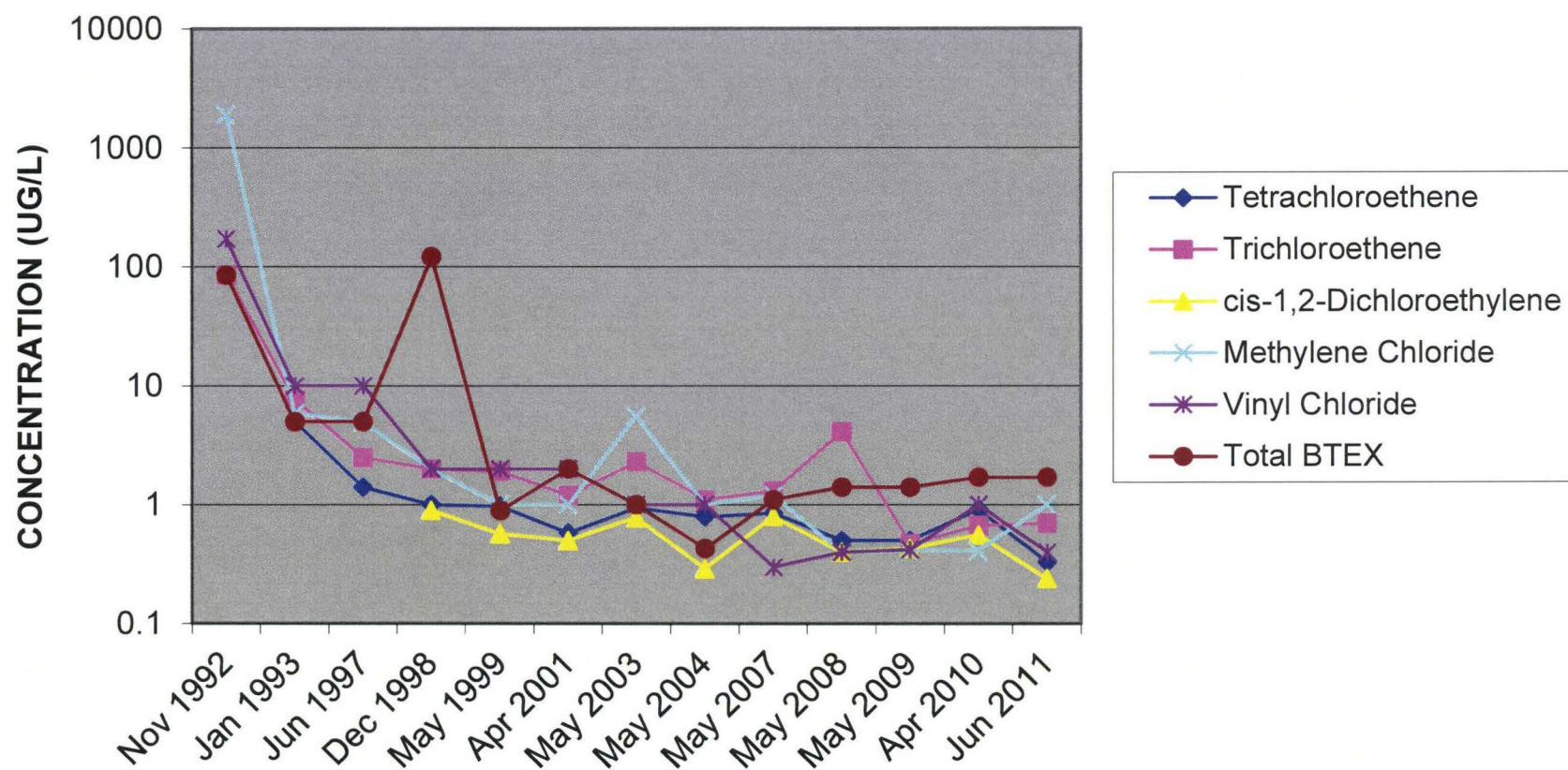
CONCENTRATIONS VS TIME IN MONITORING WELL MW-13



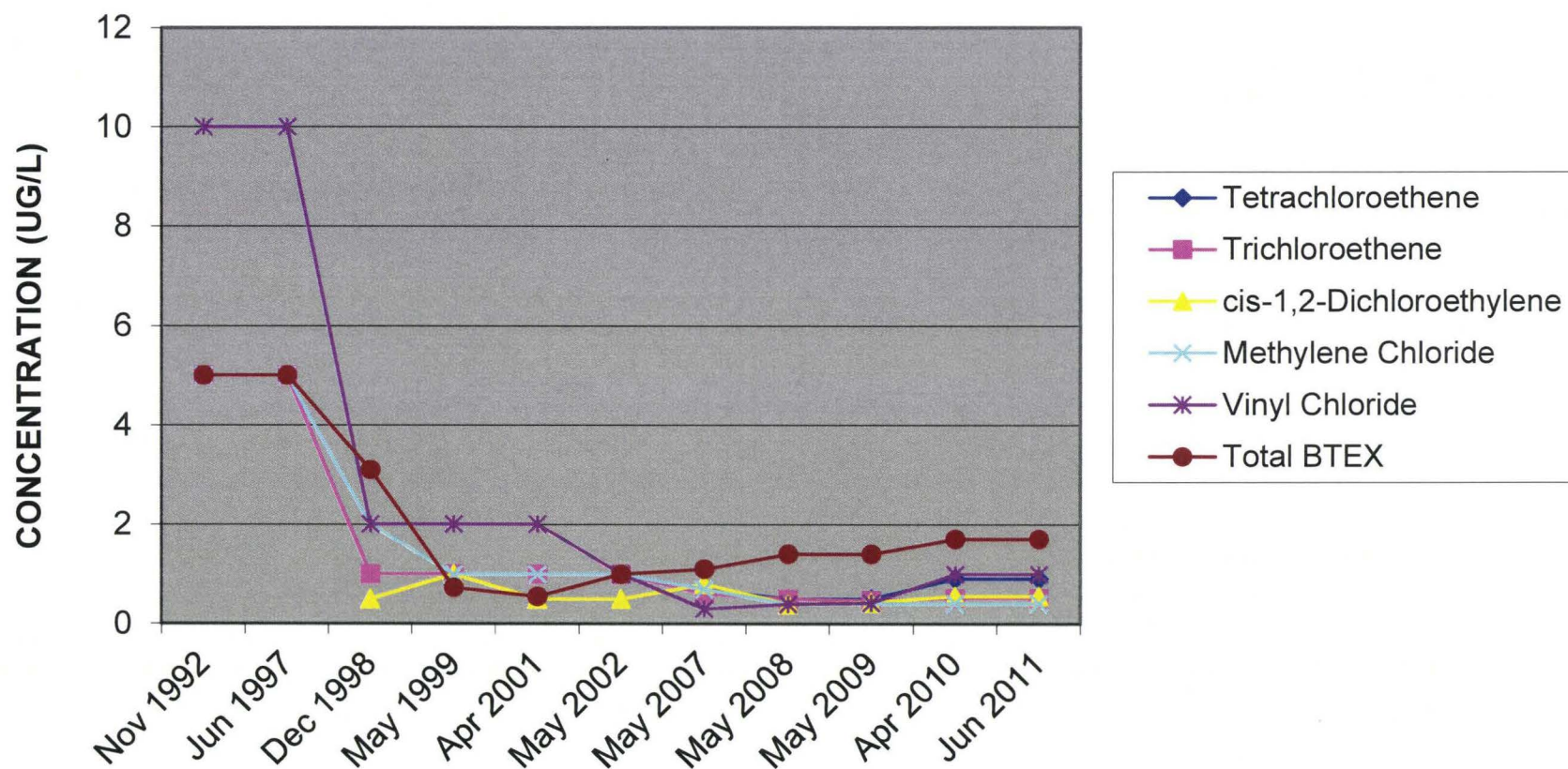
CONCENTRATIONS VS TIME IN MONITORING WELL MW-13A



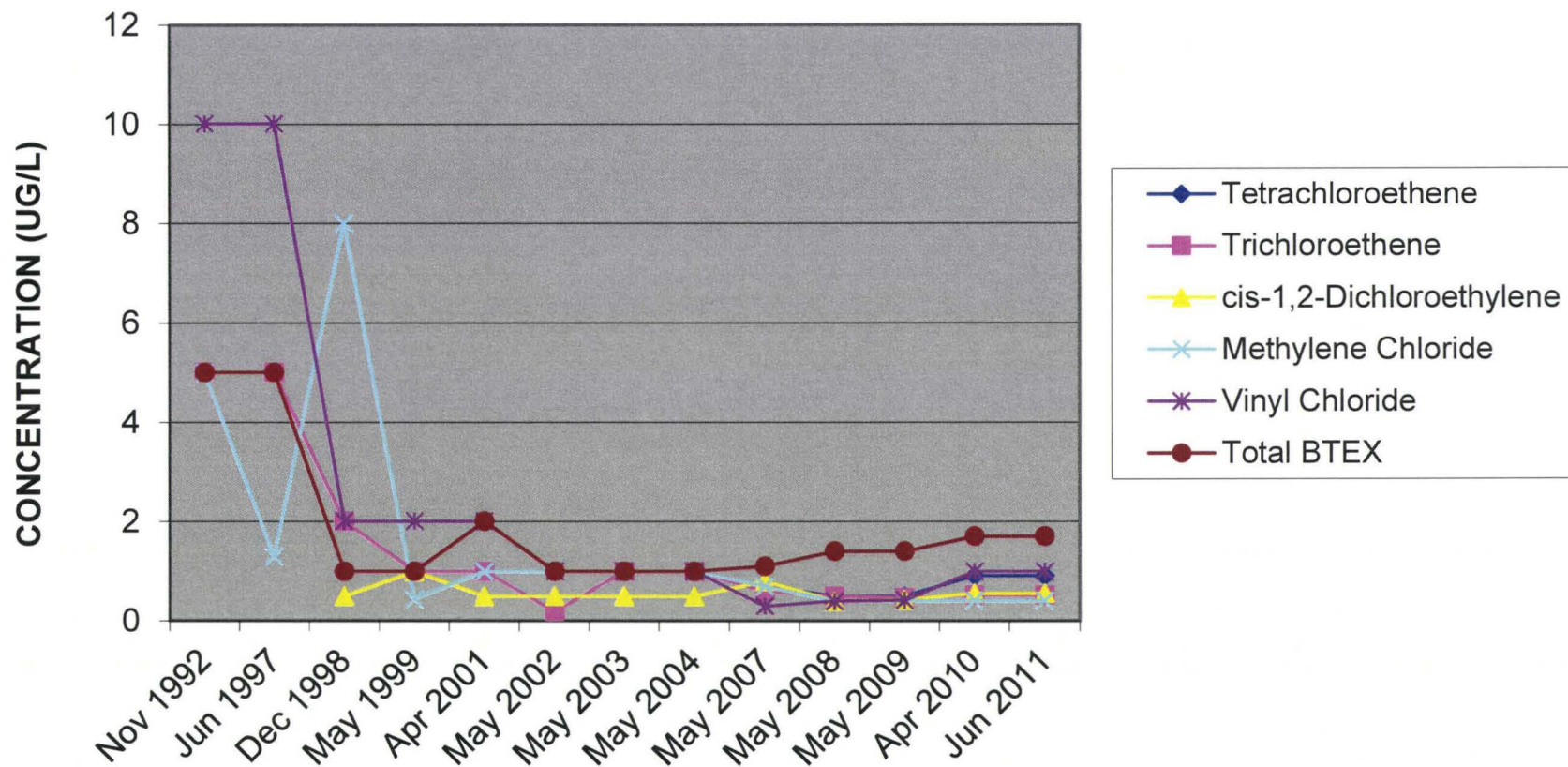
CONCENTRATIONS VS TIME IN MONITORING WELL MW-13B



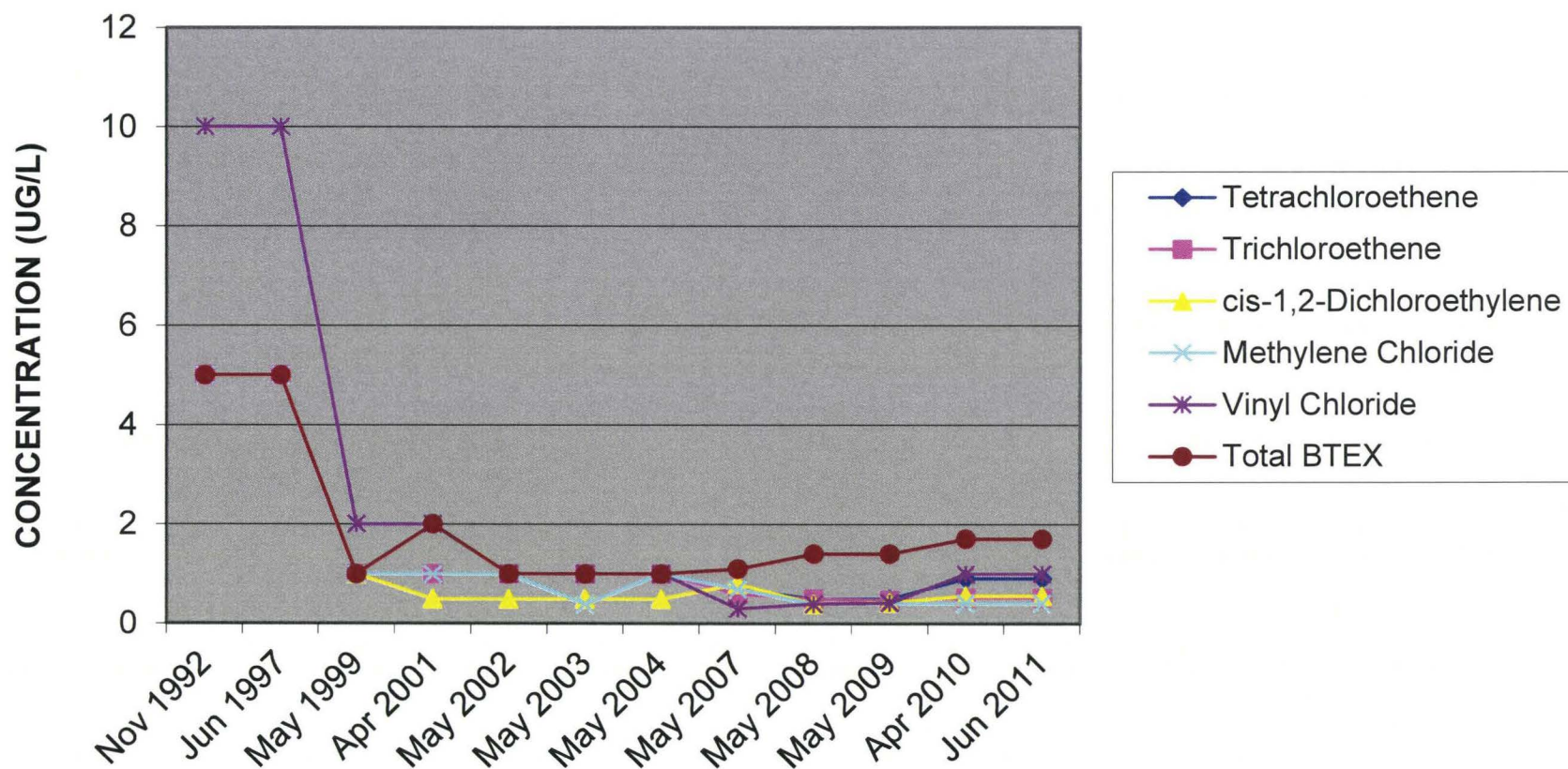
CONCENTRATIONS VS TIME IN MONITORING WELL MW-16



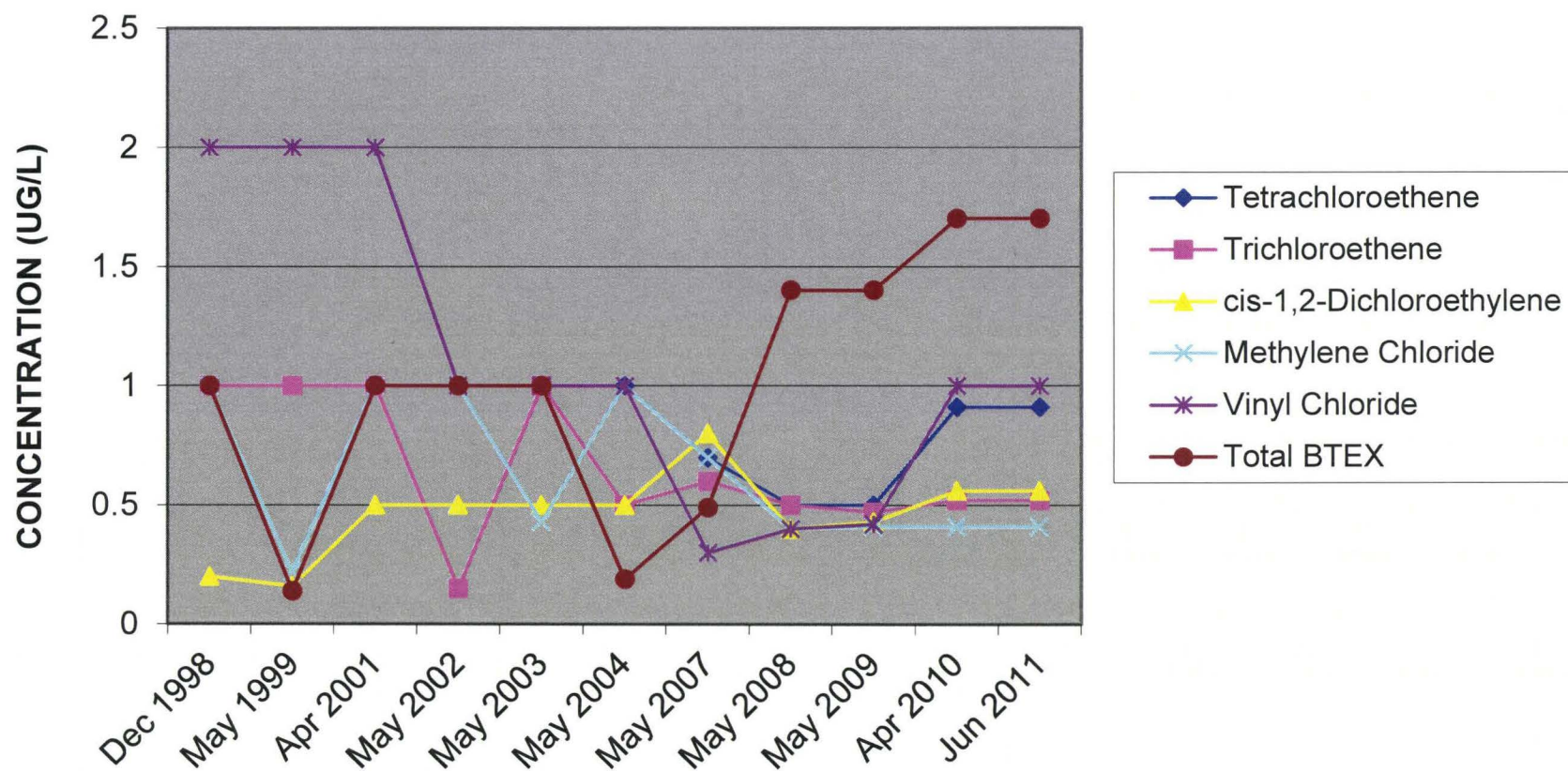
CONCENTRATIONS VS TIME IN MONITORING WELL MW-17A



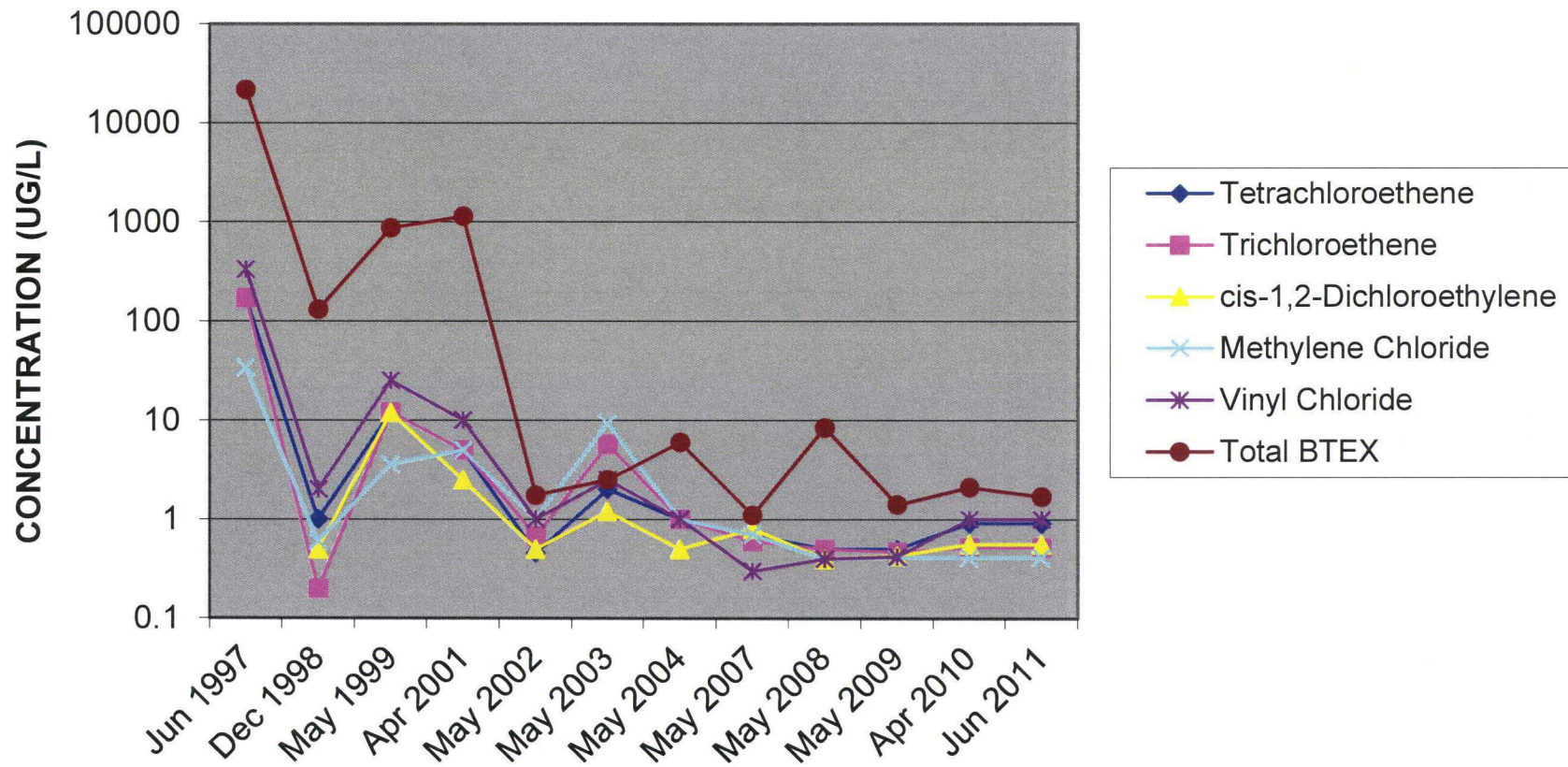
CONCENTRATIONS VS TIME IN MONITORING WELL MW-17B



CONCENTRATIONS VS TIME IN MONITORING WELL MW-19



CONCENTRATIONS VS TIME IN MONITORING WELL MW-20



MW-1

Mann-Kendall Statistical Test

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

Well Number = MW-1

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	May 1999	2000	2000	2000	680	4000	87000
2	Apr 2001	1	1	0.5	1	2	1
3	May 2002	1	0.3	0.5	1	1	23.78
4	May 2003	1	0.47	1.5	1	0.37	1.76
5	May 2004	1	0.34	1.8	1	2	1.9
6	May 2007	0.7	0.6	0.8	0.7	0.71	1.9
7	May 2008	0.5	0.5	0.4	0.4	0.4	1.4
8	May 2009	0.5	0.47	0.43	0.41	0.42	1.4
9	Apr 2010	0.91	0.52	1.8	0.41	1	1.7
10	Jun 2011	0.91	0.52	0.71	0.41	1	1.7

Mann Kendall Statistic (S) =	-25.0	-3.0	-7.0	-30.0	-13.0	-14.0
Number of Rounds (n) =	10	10	10	10	10	10
Average =	200.8	200	200.84	68.6	400.89	8704
Standard Deviation =	632.191	632.290	632.159	214.813	1264.598	27510.533
Coefficient of Variation(CV)=	3.149	3.154	3.148	3.130	3.154	3.161

Error Check, Blank if No Errors Detected

Trend \geq 80% Confidence Level	DECREASING	No Trend	No Trend	DECREASING	DECREASING	DECREASING
Trend \geq 90% Confidence Level	DECREASING	No Trend	No Trend	DECREASING	No Trend	No Trend

Stability Test, If No Trend Exists at 80% Confidence Level	NA	CV > 1 NON-STABLE	CV > 1 NON-STABLE	NA	NA	NA
--	----	----------------------	----------------------	----	----	----

Notes:

BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.

Blank Data Box - Compound not analyzed during sampling event.

MW-2/2R

Mann-Kendall Statistical Test

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

Well Number = MW-2/2R

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	Aug 1999	2500	2500	2500	1200	5000	114800
2	Apr 2001	1	1	0.4	1	2	372
3	May 2002	8.3	1.7	4.2	8.3	8.3	636.1
4	May 2003	6.2	6.2	3.1	6.2	6.2	670
5	May 2004	5	5	2.5	2.3	5	325.9
6	May 2007	0.7	0.6	0.8	0.7	0.3	41.7
7	May 2008	0.5	0.5	0.4	0.4	0.4	35.9
8	May 2009	0.5	0.47	0.43	0.41	0.42	1.4
9	Apr 2010	0.91	0.52	0.56	0.41	1	1.7
10	Jun 2011	0.91	0.52	0.71	0.41	1	1.7

Mann Kendall Statistic (S) =	-25.0	-26.0	-18.0	-30.0	-20.0	-34.0
Number of Rounds (n) =	10	10	10	10	10	10
Average =	252.4	252	251.31	122.0	502.46	11689
Standard Deviation =	789.730	789.992	790.110	378.776	1580.276	36230.586
Coefficient of Variation(CV)=	3.129	3.139	3.144	3.104	3.145	3.100

Error Check, Blank if No Errors Detected

Trend ≥ 80% Confidence Level	DECREASING	DECREASING	DECREASING	DECREASING	DECREASING	DECREASING
Trend ≥ 90% Confidence Level	DECREASING	DECREASING	DECREASING	DECREASING	DECREASING	DECREASING

Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	NA	NA	NA	NA
--	----	----	----	----	----	----

Notes:

BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.

Blank Data Box - Compound not analyzed during sampling event.

MW-3

Mann-Kendall Statistical Test

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

Well Number = MW-3

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	Aug 1999	1	1	1	1	2	0.63
2	Apr 2001	1	1	0.5	1	2	2
3	May 2002	1	1	0.5	1	1	0.2
4	May 2003	1	1	0.5	1	1	1
5	May 2004	1	1	0.5	1	1	0.21
6	May 2007	0.7	0.6	0.8	0.7	0.3	1.1
7	May 2008	0.5	0.5	0.4	0.4	0.4	1.4
8	May 2009	0.5	0.47	0.43	0.41	0.42	1.4
9	Apr 2010	0.91	0.52	0.56	0.41	1	1.7
10	Jun 2011	0.91	0.52	0.56	0.41	1	1.7

Mann Kendall Statistic (S) =	-21.0	-26.0	-4.0	-26.0	-16.0	21.0
Number of Rounds (n) =	10	10	10	10	10	10
Average =	0.9	1	0.58	0.7	1.01	1
Standard Deviation =	0.207	0.254	0.184	0.295	0.595	0.626
Coefficient of Variation(CV)=	0.243	0.334	0.321	0.402	0.588	0.552

Error Check, Blank if No Errors Detected

Trend \geq 80% Confidence Level	DECREASING	DECREASING	No Trend	DECREASING	DECREASING	INCREASING
Trend \geq 90% Confidence Level	DECREASING	DECREASING	No Trend	DECREASING	DECREASING	INCREASING

Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	CV \leq 1 STABLE	NA	NA	NA
--	----	----	-----------------------	----	----	----

Notes:

BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.

Blank Data Box - Compound not analyzed during sampling event.

MW-6A

Mann-Kendall Statistical Test

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

Well Number = MW-6A

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	May 1999	83	83	83	26	170	6800
2	May 2001	5	5	50	5	10	365.7
3	May 2002	20	20	10	20	20	1250
4	May 2003	1	1	0.5	1	1	8.05
5	May 2004	1	1	0.5	1	1	81.9
6	May 2007	0.7	0.6	0.8	0.7	0.3	16.3
7	May 2008	0.5	0.5	0.4	0.4	0.4	66.9
8	May 2009	0.5	0.47	0.43	0.41	0.42	491
9	Apr 2010	0.91	0.52	0.56	0.41	1	272
10	Jun 2011	0.91	0.52	0.56	0.41	1	280

Mann Kendall Statistic (S) =	-28.0	-33.0	-21.0	-33.0	-19.0	-7.0
Number of Rounds (n) =	10	10	10	10	10	10
Average =	11.4	11	14.68	5.5	20.51	963
Standard Deviation =	25.884	25.926	28.553	9.416	52.912	2083.372
Coefficient of Variation(CV)=	2.280	2.302	1.946	1.702	2.580	2.163

Error Check, Blank if No Errors Detected

Trend \geq 80% Confidence Level	DECREASING	DECREASING	DECREASING	DECREASING	DECREASING	No Trend
Trend \geq 90% Confidence Level	DECREASING	DECREASING	DECREASING	DECREASING	DECREASING	No Trend

Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	NA	NA	NA	CV > 1 NON-STABLE
--	----	----	----	----	----	----------------------

Notes:

BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.

Blank Data Box - Compound not analyzed during sampling event.

MW-7

Mann-Kendall Statistical Test

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

Well Number = MW-7

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	Nov 1991	2.2	8.5		2.7	4.1	5
2	Jun 1997	2.7	11		5	2.7	5
3	May 1999	4.4	14	40	1	3	1
4	May 2001	9.0	24	100	1	7.3	2
5	May 2002	7.7	20	76	0.69	4.4	2
6	May 2007	5.7	15.5	62.2	0.7	4.6	1.1
7	May 2008	9.2	19.6	0.4	0.4	0.4	1.4
8	May 2009	7.2	19.6	100	0.41	4	1.4
9	Apr 2010	6.8	19.3	113	0.41	4	1.7
10	Jun 2011	6	16.7	109	0.41	4.6	1.7

Mann Kendall Statistic (S) =	15.0	12.0	11.0	-31.0	5.0	-11.0
Number of Rounds (n) =	10	10	8	10	10	10
Average =	6.1	17	75.08	1.3	3.91	2
Standard Deviation =	2.406	4.668	39.288	1.481	1.743	1.497
Coefficient of Variation(CV)=	0.395	0.278	0.523	1.164	0.446	0.671

Error Check, Blank if No Errors Detected

Trend ≥ 80% Confidence Level	INCREASING	INCREASING	INCREASING	DECREASING	No Trend	DECREASING
Trend ≥ 90% Confidence Level	No Trend	No Trend	INCREASING	DECREASING	No Trend	No Trend

Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	NA	NA	CV ≤ 1 STABLE	NA
--	----	----	----	----	------------------	----

Notes:

BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.

Blank Data Box - Compound not analyzed during sampling event.

MW-10**Mann-Kendall Statistical Test**

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

Well Number = **MW-10**

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	May 1999	960	1700	160	8300	330	186
2	Apr 2001	330	650	71	1500	40	22
3	May 2002	250	550	200	400	400	400
4	May 2003	830	1700	330	5000	670	670
5	May 2004	770	2000	830	10000	1700	1700
6	May 2007	1260	2040	46.5	8680	4.4	3.54
7	May 2008	308	485	18.7	2820	1.7	1.4
8	May 2009	588	1610	34.1	5480	2.7	1.4
9	Apr 2010	571	1190	39.2	2230	2	1.7
10	Jun 2011	413	966	29.3	4250	1	1.7

Mann Kendall Statistic (S) =	-7.0	-4.0	-19.0	-1.0	-23.0	-17.0
Number of Rounds (n) =	10	10	10	10	10	10
Average =	628.0	1289	175.88	4866.0	315.18	299
Standard Deviation =	325.880	598.646	250.593	3263.962	539.140	541.740
Coefficient of Variation(CV)=	0.519	0.464	1.425	0.671	1.711	1.813

Error Check, Blank if No Errors Detected

Trend ≥ 80% Confidence Level	No Trend	No Trend	DECREASING	No Trend	DECREASING	DECREASING
Trend ≥ 90% Confidence Level	No Trend	No Trend	DECREASING	No Trend	DECREASING	DECREASING

Stability Test, If No Trend Exists at 80% Confidence Level	CV <= 1 STABLE	CV <= 1 STABLE	NA	CV <= 1 STABLE	NA	NA
--	------------------------------------	------------------------------------	----	------------------------------------	----	----

Notes:

BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.

Blank Data Box - Compound not analyzed during sampling event.

MW-10A

Mann-Kendall Statistical Test

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

Well Number = MW-10A

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	May 1999	2.4	5	8.3	5.3	1.4	326.7
2	Apr 2001	0.54	1.1	2.5	1	0.59	118.6
3	May 2002	1.6	2.6	6	1.7	0.88	96.9
4	May 2003	1.1	1.5	4	1.7	0.8	4.95
5	May 2004	1.4	1.9	5	0.53	1	3.87
6	May 2007	0.96	1.6	5.2	0.7	3.4	1.9
7	May 2008	1.5	5.4	12.3	0.4	9.4	1.4
8	May 2009	0.5	0.47	0.43	0.41	0.42	1.4
9	Apr 2010	0.91	1	2.5	0.41	1	1.7
10	Jun 2011	0.91	0.64	1.4	0.41	1	1.7

Mann Kendall Statistic (S) =	-18.0	-17.0	-14.0	-29.0	6.0	-35.0
Number of Rounds (n) =	10	10	10	10	10	10
Average =	1.2	2	4.76	1.3	1.99	56
Standard Deviation =	0.566	1.738	3.528	1.510	2.734	104.870
Coefficient of Variation(CV)=	0.479	0.820	0.741	1.202	1.374	1.876

Error Check, Blank if No Errors Detected

Trend ≥ 80% Confidence Level	DECREASING	DECREASING	DECREASING	DECREASING	No Trend	DECREASING
Trend ≥ 90% Confidence Level	DECREASING	DECREASING	No Trend	DECREASING	No Trend	DECREASING

Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	NA	NA	CV > 1 NON-STABLE	NA
--	----	----	----	----	----------------------	----

Notes:

BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.

Blank Data Box - Compound not analyzed during sampling event.

MW-13

Mann-Kendall Statistical Test

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

Well Number = MW-13

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	May 1999	890.0	1600	580	21000	200	1484
2	Apr 2001	530	1300	710	13000	32	630
3	May 2002	440	1000	580	14000	420	270
4	May 2003	520	950	580	14000	500	500
5	May 2004	330	620	410	11000	330	330
6	May 2007	437	876	537	11300	27.7	16.1
7	May 2008	312	649	423	9320	17.5	25.5
8	May 2009	76.8	194	103	2240	2.9	1.4
9	Apr 2010	171	370	197	3900	9.7	1.7
10	Jun 2011	270	602	310	6390	11.4	3.24

Mann Kendall Statistic (S) =	-35.0	-35.0	-30.0	-32.0	-25.0	-33.0
Number of Rounds (n) =	10	10	10	10	10	10
Average =	397.7	816	443.00	10615.0	155.12	326
Standard Deviation =	226.264	421.930	191.986	5495.754	193.508	467.601
Coefficient of Variation(CV)=	0.569	0.517	0.433	0.518	1.247	1.434

Error Check, Blank if No Errors Detected

Trend ≥ 80% Confidence Level	DECREASING	DECREASING	DECREASING	DECREASING	DECREASING	DECREASING
Trend ≥ 90% Confidence Level	DECREASING	DECREASING	DECREASING	DECREASING	DECREASING	DECREASING

Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	NA	NA	NA	NA
--	----	----	----	----	----	----

Notes:

BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.

Blank Data Box - Compound not analyzed during sampling event.

MW-13A
Mann-Kendall Statistical Test

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

 Well Number = **MW-13A**

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	May 1999	1.7	1.7	0.94	4.4	3.3	56.4
2	Apr 2001	1	2.4	2.4	1	0.89	5.3
3	May 2002	1	1	0.61	0.44	0.35	25.5
4	May 2003	1	1	0.45	0.39	1	4.5
5	May 2004	1	1	0.54	1	0.31	6.71
6	May 2007	0.7	0.6	0.8	0.7	0.41	5.2
7	May 2008	0.5	0.5	0.4	0.4	0.4	5.3
8	May 2009	0.5	0.47	0.43	0.41	0.42	4.6
9	Apr 2010	0.91	0.52	0.56	0.41	1	3.5
10	Jun 2011	0.33	1.4	1.2	1	0.94	5.1

Mann Kendall Statistic (S) =	-32.0	-22.0	-9.0	-11.0	0.0	-24.0
Number of Rounds (n) =	10	10	10	10	10	10
Average =	0.9	1	0.83	1.0	0.90	12
Standard Deviation =	0.388	0.623	0.606	1.220	0.891	16.826
Coefficient of Variation(CV)=	0.449	0.589	0.728	1.202	0.988	1.378

Error Check, Blank if No Errors Detected

Trend ≥ 80% Confidence Level	DECREASING	DECREASING	No Trend	DECREASING	No Trend	DECREASING
Trend ≥ 90% Confidence Level	DECREASING	DECREASING	No Trend	No Trend	No Trend	DECREASING

Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	CV ≤ 1 STABLE	NA	CV ≤ 1 STABLE	NA
--	----	----	--------------------------	----	--------------------------	----

Notes:
BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.

Blank Data Box - Compound not analyzed during sampling event.

MW-13B

Mann-Kendall Statistical Test

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

Well Number = MW-13B

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	Dec 1998	1.0	2	0.9	2	2	120
2	May 1999	0.97	1.9	0.57	1	2	0.89
3	Apr 2001	0.58	1.2	0.5	1	2	2
4	May 2003	0.94	2.3	0.78	5.6	1	1
5	May 2004	0.79	1.1	0.29	1	1	0.43
6	May 2007	0.85	1.3	0.8	1.2	0.3	1.1
7	May 2008	0.5	4.1	0.4	0.4	0.4	1.4
8	May 2009	0.5	0.47	0.43	0.41	0.42	1.4
9	Apr 2010	0.91	0.67	0.56	0.41	1	1.7
10	Jun 2011	0.33	0.7	0.24	1	0.4	1.7

Mann Kendall Statistic (S) =	-26.0	-17.0	-19.0	-16.0	-24.0	7.0
Number of Rounds (n) =	10	10	10	10	10	10
Average =	0.7	2	0.55	1.4	1.05	13
Standard Deviation =	0.239	1.077	0.221	1.551	0.709	37.542
Coefficient of Variation(CV)=	0.324	0.684	0.405	1.106	0.674	2.852

Error Check, Blank if No Errors Detected

Trend \geq 80% Confidence Level	DECREASING	DECREASING	DECREASING	DECREASING	DECREASING	No Trend
Trend \geq 90% Confidence Level	DECREASING	DECREASING	DECREASING	DECREASING	DECREASING	No Trend

Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	NA	NA	NA	CV > 1 NON-STABLE
--	----	----	----	----	----	----------------------

Notes:

BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.

Blank Data Box - Compound not analyzed during sampling event.

MW-16

Mann-Kendall Statistical Test

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

Well Number = MW-16

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	Jun 1997	5	5		5	10	5
2	Dec 1998	1	1	0.5	2	2	3.1
3	May 1999	1	1	1	1	2	0.73
4	Apr 2001	1.0	1	0.5	1	2	0.55
5	May 2002	1	1	0.5	1	1	1
6	May 2007	0.7	0.6	0.8	0.7	0.3	1.1
7	May 2008	0.5	0.5	0.4	0.4	0.4	1.4
8	May 2009	0.5	0.47	0.43	0.41	0.42	1.4
9	Apr 2010	0.91	0.52	0.56	0.41	1	1.7
10	Jun 2011	0.91	0.52	0.56	0.41	1	1.7

Mann Kendall Statistic (S) =	-25.0	-30.0	-2.0	-33.0	-21.0	7.0
Number of Rounds (n) =	10	10	9	10	10	10
Average =	1.3	1	0.58	1.2	2.01	2
Standard Deviation =	1.332	1.370	0.194	1.412	2.886	1.337
Coefficient of Variation(CV)=	1.064	1.180	0.332	1.145	1.434	0.756

Error Check, Blank if No Errors Detected

Trend \geq 80% Confidence Level	DECREASING	DECREASING	No Trend	DECREASING	DECREASING	No Trend
Trend \geq 90% Confidence Level	DECREASING	DECREASING	No Trend	DECREASING	DECREASING	No Trend

Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	CV \leq 1 STABLE	NA	NA	CV \leq 1 STABLE
--	----	----	-----------------------	----	----	-----------------------

Notes:

BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.

Blank Data Box - Compound not analyzed during sampling event.

MW-17A

Mann-Kendall Statistical Test

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

Well Number = MW-17A

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	May 1999	1	1	1	0.44	2	1
2	Apr 2001	1.0	1	0.5	1	2	2
3	May 2002	1	0.19	0.5	1	1	1
4	May 2003	1	1	0.5	1	1	1
5	May 2004	1	1	0.5	1	1	1
6	May 2007	0.7	0.6	0.8	0.7	0.3	1.1
7	May 2008	0.5	0.5	0.4	0.4	0.4	1.4
8	May 2009	0.5	0.47	0.43	0.41	0.42	1.4
9	Apr 2010	0.91	0.52	0.56	0.41	1	1.7
10	Jun 2011	0.91	0.52	0.56	0.41	1	1.7

Mann Kendall Statistic (S) =	-21.0	-16.0	-4.0	-20.0	-16.0	21.0
Number of Rounds (n) =	10	10	10	10	10	10
Average =	0.9	1	0.58	0.7	1.01	1
Standard Deviation =	0.207	0.295	0.184	0.291	0.595	0.368
Coefficient of Variation(CV)=	0.243	0.434	0.321	0.431	0.588	0.277

Error Check, Blank if No Errors Detected

Trend \geq 80% Confidence Level	DECREASING	DECREASING	No Trend	DECREASING	DECREASING	INCREASING
Trend \geq 90% Confidence Level	DECREASING	DECREASING	No Trend	DECREASING	DECREASING	INCREASING

Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	CV \leq 1 STABLE	NA	NA	NA
--	----	----	-----------------------	----	----	----

Notes:

BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.

Blank Data Box - Compound not analyzed during sampling event.

MW-17B

Mann-Kendall Statistical Test

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

Well Number = MW-17B

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	May 1999	1	1	1	1	2	1
2	Apr 2001	1	1	0.5	1	2	2
3	May 2002	1.0	1	0.5	1	1	1
4	May 2003	1	1	0.5	0.39	1	1
5	May 2004	1	1	0.5	1	1	1
6	May 2007	0.7	0.6	0.8	0.7	0.3	1.1
7	May 2008	0.5	0.5	0.4	0.4	0.4	1.4
8	May 2009	0.5	0.47	0.43	0.41	0.42	1.4
9	Apr 2010	0.91	0.52	0.56	0.41	1	1.7
10	Jun 2011	0.91	0.52	0.56	0.41	1	1.7

Mann Kendall Statistic (S) =	-21.0	-26.0	-4.0	-18.0	-16.0	21.0
Number of Rounds (n) =	10	10	10	10	10	10
Average =	0.9	1	0.58	0.7	1.01	1
Standard Deviation =	0.207	0.254	0.184	0.296	0.595	0.368
Coefficient of Variation(CV)=	0.243	0.334	0.321	0.441	0.588	0.277

Error Check, Blank if No Errors Detected

Trend ≥ 80% Confidence Level	DECREASING	DECREASING	No Trend	DECREASING	DECREASING	INCREASING
Trend ≥ 90% Confidence Level	DECREASING	DECREASING	No Trend	DECREASING	DECREASING	INCREASING

Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	CV ≤ 1 STABLE	NA	NA	NA
--	----	----	------------------	----	----	----

Notes:

BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.
Blank Data Box - Compound not analyzed during sampling event.

MW-19

Mann-Kendall Statistical Test

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

Well Number = MW-19

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	May 1999	1	1	0.16	0.22	2	0.14
2	Apr 2001	1	1	0.5	1	2	1
3	May 2002	1	0.15	0.5	1	1	1
4	May 2003	1.0	1	0.5	0.43	1	1
5	May 2004	1	0.5	0.5	1	1	0.19
6	May 2007	0.7	0.6	0.8	0.7	0.3	0.49
7	May 2008	0.5	0.5	0.4	0.4	0.4	1.4
8	May 2009	0.5	0.47	0.43	0.41	0.42	1.4
9	Apr 2010	0.91	0.52	0.56	0.41	1	1.7
10	Jun 2011	0.91	0.52	0.56	0.41	1	1.7

Mann Kendall Statistic (S) =	-21.0	-12.0	14.0	-11.0	-16.0	28.0
Number of Rounds (n) =	10	10	10	10	10	10
Average =	0.9	1	0.49	0.6	1.01	1
Standard Deviation =	0.207	0.284	0.159	0.300	0.595	0.573
Coefficient of Variation(CV)=	0.243	0.454	0.323	0.502	0.588	0.572

Error Check, Blank if No Errors Detected

Trend \geq 80% Confidence Level	DECREASING	DECREASING	INCREASING	DECREASING	DECREASING	INCREASING
Trend \geq 90% Confidence Level	DECREASING	No Trend	No Trend	No Trend	DECREASING	INCREASING

Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	NA	NA	NA	NA
--	----	----	----	----	----	----

Notes:

BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.

Blank Data Box - Compound not analyzed during sampling event.

MW-20

Mann-Kendall Statistical Test

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

Well Number = MW-20

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	May 1999	12	12	12	3.6	25	863
2	Apr 2001	5	5	2.5	5	10	1130
3	May 2002	0.5	0.68	0.5	1	1	1.75
4	May 2003	2	5.7	1.2	9.4	2.5	2.5
5	May 2004	1	1	0.5	1	1	5.97
6	May 2007	0.7	0.6	0.8	0.7	0.3	1.1
7	May 2008	0.5	0.5	0.4	0.4	0.4	8.4
8	May 2009	0.5	0.47	0.43	0.41	0.42	1.4
9	Apr 2010	0.91	0.52	0.56	0.41	1	2.1
10	Jun 2011	0.91	0.52	0.56	0.41	1	1.7

Mann Kendall Statistic (S) =	-17.0	-30.0	-19.0	-27.0	-19.0	-17.0
Number of Rounds (n) =	10	10	10	10	10	10
Average =	2.4	3	1.95	2.2	4.26	202
Standard Deviation =	3.642	3.822	3.590	2.974	7.846	423.556
Coefficient of Variation(CV)=	1.519	1.416	1.846	1.332	1.841	2.099

Error Check, Blank if No Errors Detected

Trend ≥ 80% Confidence Level	DECREASING	DECREASING	DECREASING	DECREASING	DECREASING	DECREASING
Trend ≥ 90% Confidence Level	DECREASING	DECREASING	DECREASING	DECREASING	DECREASING	DECREASING

Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	NA	NA	NA	NA
--	----	----	----	----	----	----

Notes:

BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.

Blank Data Box - Compound not analyzed during sampling event.

MW-23A

Mann-Kendall Statistical Test

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

Well Number = MW-23A

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	May 1999	1	1	1	1	2	1
2	Apr 2001	1	1	0.5	1	2	2
3	May 2002	1	1	0.5	1	1	1
4	May 2003	1.0	1	0.5	1	1	1
5	May 2004	1	1	0.5	1	1	1
6	May 2007	0.7	0.6	0.8	0.7	0.3	1.1
7	May 2008	0.5	0.5	0.4	0.4	0.4	1.4
8	May 2009	0.5	0.47	0.43	0.41	0.42	1.4
9	Apr 2010	0.91	0.52	0.56	0.41	1	1.7
10	Jun 2011	0.91	0.52	0.56	0.41	1	1.7

Mann Kendall Statistic (S) =	-21.0	-26.0	-4.0	-26.0	-16.0	21.0
Number of Rounds (n) =	10	10	10	10	10	10
Average =	0.9	1	0.58	0.7	1.01	1
Standard Deviation =	0.207	0.254	0.184	0.295	0.595	0.368
Coefficient of Variation(CV)=	0.243	0.334	0.321	0.402	0.588	0.277

Error Check. Blank if No Errors Detected

Trend \geq 80% Confidence Level	DECREASING	DECREASING	No Trend	DECREASING	DECREASING	INCREASING
Trend \geq 90% Confidence Level	DECREASING	DECREASING	No Trend	DECREASING	DECREASING	INCREASING

Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	CV \leq 1 STABLE	NA	NA	NA
--	----	----	-----------------------	----	----	----

Notes:

BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.

Blank Data Box - Compound not analyzed during sampling event.

MW-23B

Mann-Kendall Statistical Test

Site Name = Facility at 3200 MainStreet, Keokuk, Iowa

Well Number = MW-23B

Event Number	Sampling Date	Tetrachloroethene UG/L	Trichloroethene UG/L	cis-1,2-Dichloroethylene UG/L	Methylene Chloride UG/L	Vinyl Chloride UG/L	Total BTEX UG/L
1	May 1999	1	1	1	0.48	2	0.3
2	Apr 2001	1	1	0.5	1	2	2
3	May 2002	1	1	0.5	1	1	0.27
4	May 2003	1.0	1	0.5	0.42	1	1
5	May 2004	1	1	0.5	1	1	1
6	May 2007	0.7	0.6	0.8	0.7	0.3	0.4
7	May 2008	0.5	0.5	0.4	0.4	0.4	1.4
8	May 2009	0.5	0.47	0.43	0.41	0.42	1.4
9	Apr 2010	0.91	0.52	0.56	0.41	1	1.7
10	Jun 2011	0.91	0.52	0.56	0.41	1	1.7

Mann Kendall Statistic (S) =	-21.0	-26.0	-4.0	-21.0	-16.0	20.0
Number of Rounds (n) =	10	10	10	10	10	10
Average =	0.9	1	0.58	0.6	1.01	1
Standard Deviation =	0.207	0.254	0.184	0.275	0.595	0.628
Coefficient of Variation(CV)=	0.243	0.334	0.321	0.441	0.588	0.562

Error Check, Blank if No Errors Detected

Trend ≥ 80% Confidence Level	DECREASING	DECREASING	No Trend	DECREASING	DECREASING	INCREASING
Trend ≥ 90% Confidence Level	DECREASING	DECREASING	No Trend	DECREASING	DECREASING	INCREASING

Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	CV ≤ 1 STABLE	NA	NA	NA
--	----	----	------------------	----	----	----

Notes:

BOLD - Compound not detected above Detection Limit (DL). DL value used in the statistical test.

Blank Data Box - Compound not analyzed during sampling event.

APPENDIX D

CD with Laboratory Analytical Data Reports and Report Drawings

Distances along the plume centerline Used for plume migration calculations

Facility at 3200 Main Street, Keokuk, Iowa

Notes by David Dods, June 5, 2010

The plume centerline was first plotted in 2007 based on consistent historic plume patterns. That line is shown as the faint brown line on the plume maps. The starting or zero point of the line was set near former well MW-2 so that plume distances would be measured from the same starting point each year.

Well distances along the line from the zero point are:

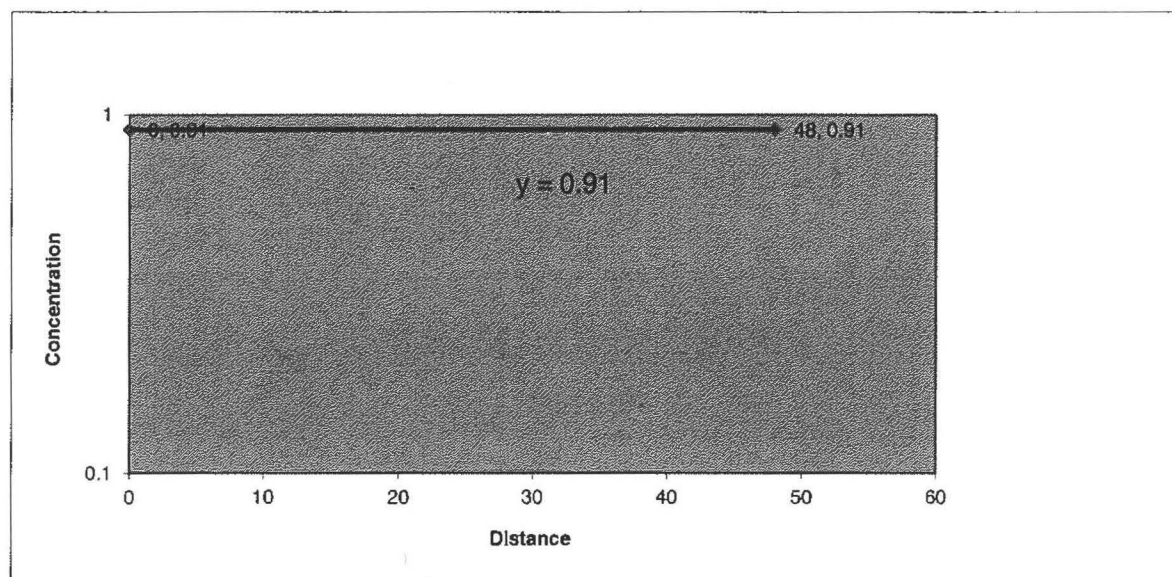
Distance Along Centerline		Distance Between Wells	
Well	ft	Wells	ft
MW-10	72.2	MW-10, MW-13	32.2
MW-10A	67.3	MW-10A, MW-13A	48.4
MW-13	104.4	MW-10, MW-23B	180.1
MW-13A	115.7	MW-10A, MW-23A	176.4
MW-13B	103.8	MW-13, MW-23B	147.9
MW-23A	243.7	MW-13A, MW-23A	128
MW-23B	252.3		

BULK ATTENUATION RATE CALCULATION FOR TETRACHLOROETHYLENE IN PLUME FILL WELLS

Monitoring Well	Feet from Source	(ug/L)	
MW-10A (source)	0	0.91	RL
MW-13A	48	0.91	RL

Slope	Seepage Velocity (Feet per Day)	k	Retardation Factor
0	0.017	0.0000	1

Contour Interval (ug/L)	Distance from Source (Feet)
5	NA
10	NA
100	NA
1000	NA



Notes:

k - Concentration vs. Distance rate constant

Seepage Velocity - calculated from June 2011 water levels

Retardation Factor - assumed to be 1 to be conservative

RL - Reporting Limit

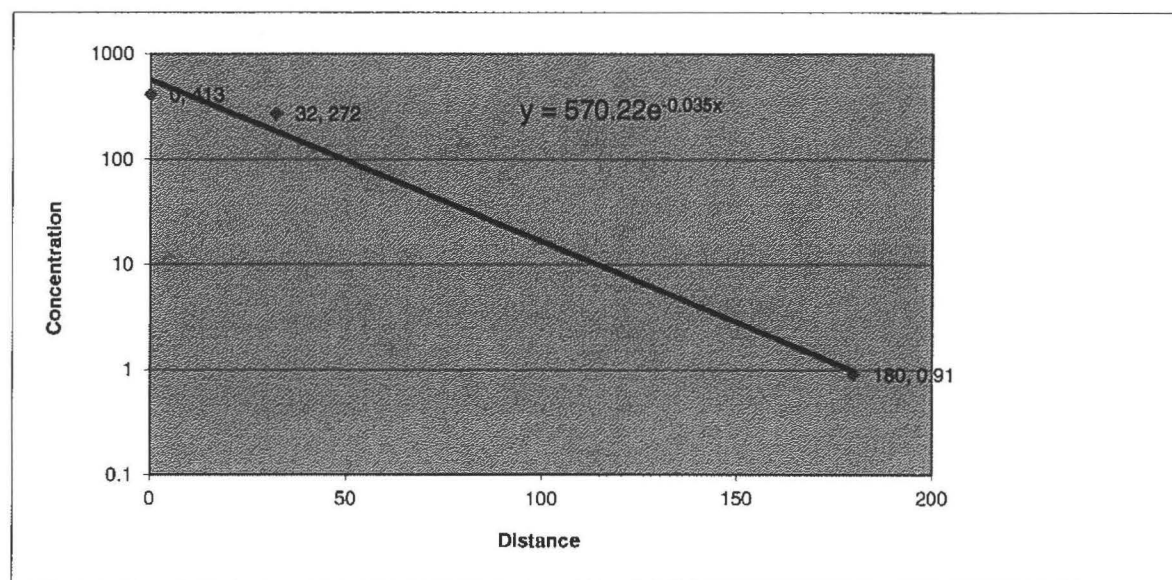
NA - Not applicable, calculated concentration level less than MCL

BULK ATTENUATION RATE CALCULATION FOR TETRACHLOROETHYLENE IN PLUME TILL WELLS

Monitoring Well	Feet from Source	(ug/L)	
MW-10 (source)	0	413	
MW-13	32	272	
MW-23B	180	0.91	RL

Slope	Seepage Velocity (Feet per Day)	k	Retardation Factor
0.035	0.011	0.0004	1

Contour Interval (ug/L)	Distance from Source (Feet)	Distance along plume CL (from zero point)
5	126.11	198.31
10	106.31	178.51
100	40.52	112.72
1000	NA	



Notes:

k - Concentration vs. Distance rate constant

Seepage Velocity - calculated from June 2011 water levels

Retardation Factor - assumed to be 1 to be conservative

RL - Reporting Limit

J - Concentration is estimated or detected below RL

The higher result of MW-13 and MW-13 Dup was used

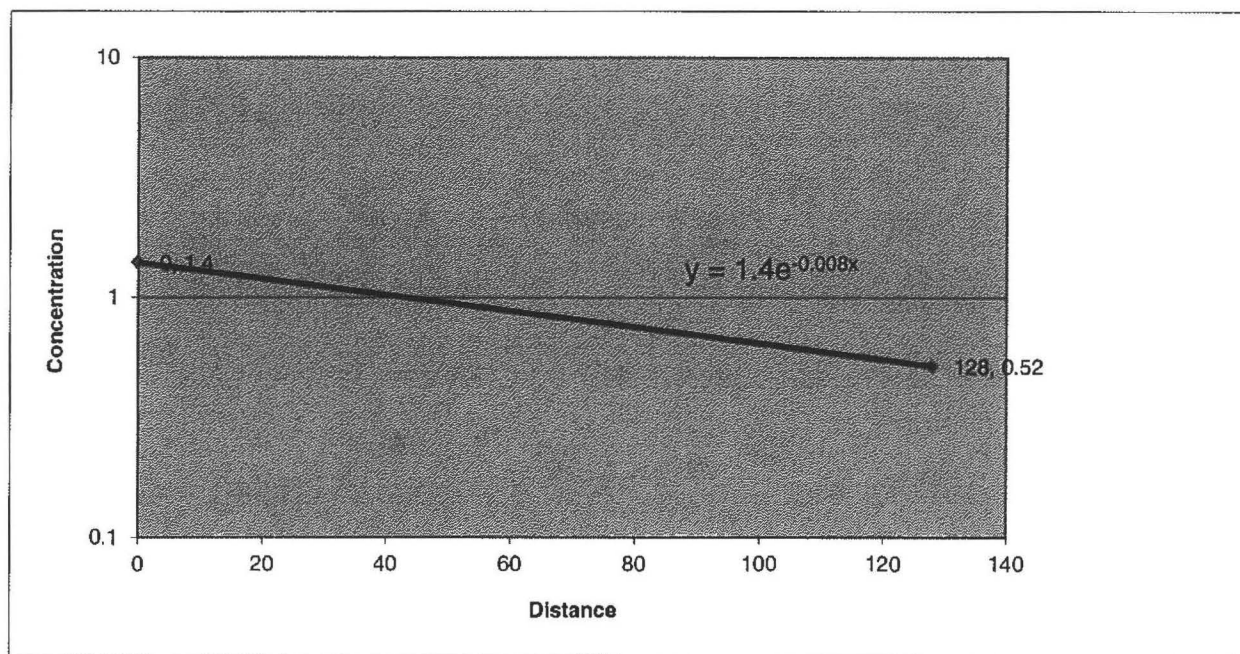
CL - Centerline

NA - Not applicable

BULK ATTENUATION RATE CALCULATION FOR TRICHLOROETHENE IN PLUME FILL WELLS

Monitoring Well	Feet from Source	(ug/L)	
MW-10A	NA	0.64	J
MW-13A (source)	0	1.4	
MW-23A	128	0.52	RL
Slope	Seepage Velocity (Feet per Day)	k	Retardation Factor
0.008	0.017	0.0001	1

Contour Interval (ug/L)	Distance from Source (Feet)	Distance along plume CL (from zero point)
5	NA	
10	NA	
100	NA	
1000	NA	



Notes:

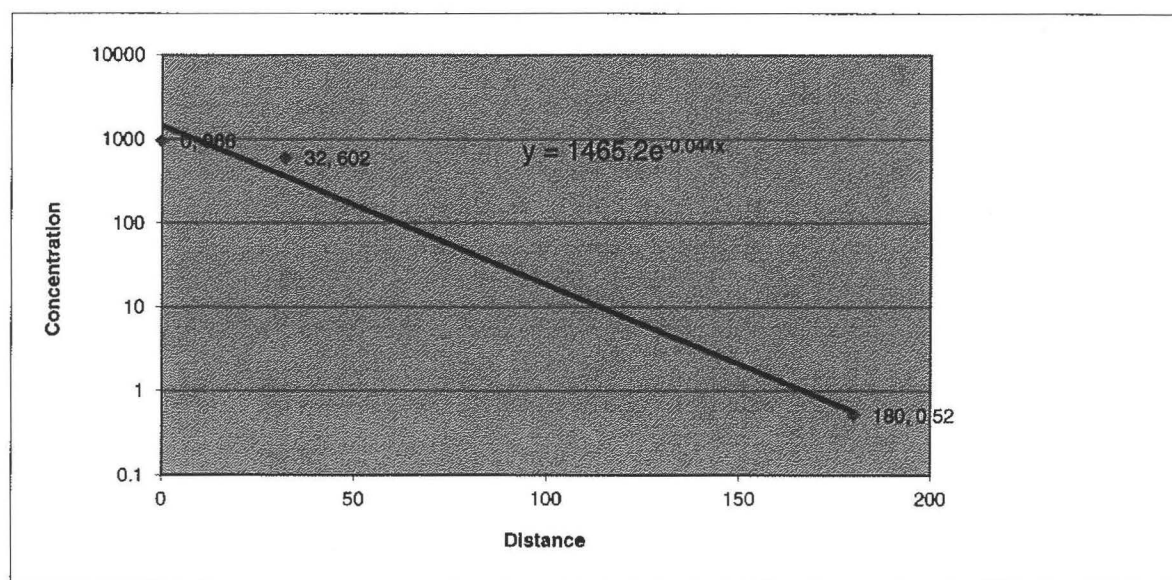
- k - Concentration vs. Distance rate constant
- Seepage Velocity - calculated from June 2011 water levels
- Retardation Factor - assumed to be 1 to be conservative
- RL - Reporting Limit
- NA - Not applicable
- CL - Centerline

BULK ATTENUATION RATE CALCULATION FOR TRICHLOROETHENE IN PLUME TILL WELLS

Monitoring Well	Feet from Source	(ug/L)
MW-10 (source)	0	966
MW-13	32	602
MW-23B	180	0.52 RL

Slope	Seepage Velocity (Feet per Day)	k	Retardation Factor
0.044	0.011	0.0005	1

Contour Interval (ug/L)	Distance from Source (Feet)	Distance along plume CL (from zero point)
5	119.63	191.83
10	103.88	176.08
100	51.55	123.75
1000	-0.79	71.41



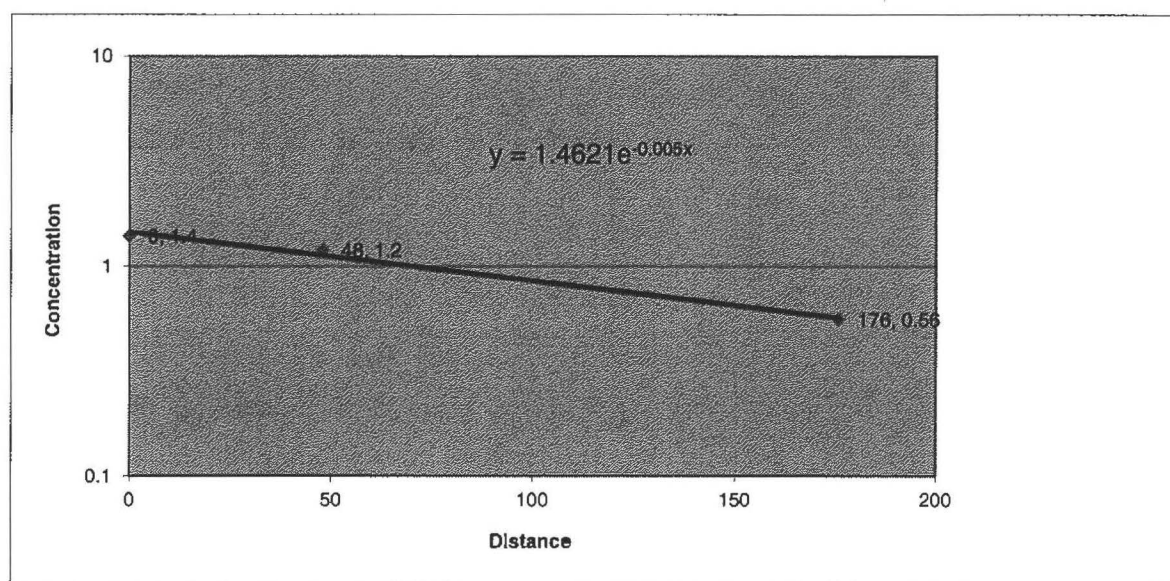
Notes:

k - Concentration vs. Distance rate constant
 Seepage Velocity - calculated from June 2011 water levels
 Retardation Factor - assumed to be 1 to be conservative
 RL - Reporting Limit
 The higher result of MW-13 and MW-13 Dup was used
 CL - Centerline

BULK ATTENUATION RATE CALCULATION FOR CIS-1, 2-DICHLOROETHYLENE IN PLUME FILL WELLS

Monitoring Well	Feet from Source	(ug/L)	
MW-10A (source)	0	1.4	J
MW-13A	48	1.2	
MW-23A	176	0.56	RL
Slope	Seepage Velocity (Feet per Day)	k	Retardation Factor
0.005	0.017	0.0001	1

Contour Interval (ug/L)	Distance from Source (Feet)
70	NA
100	NA



Notes:

k - Concentration vs. Distance rate constant

Seepage Velocity - calculated from June 2011 water levels

Retardation Factor - assumed to be 1 to be conservative

RL - Reporting Limit

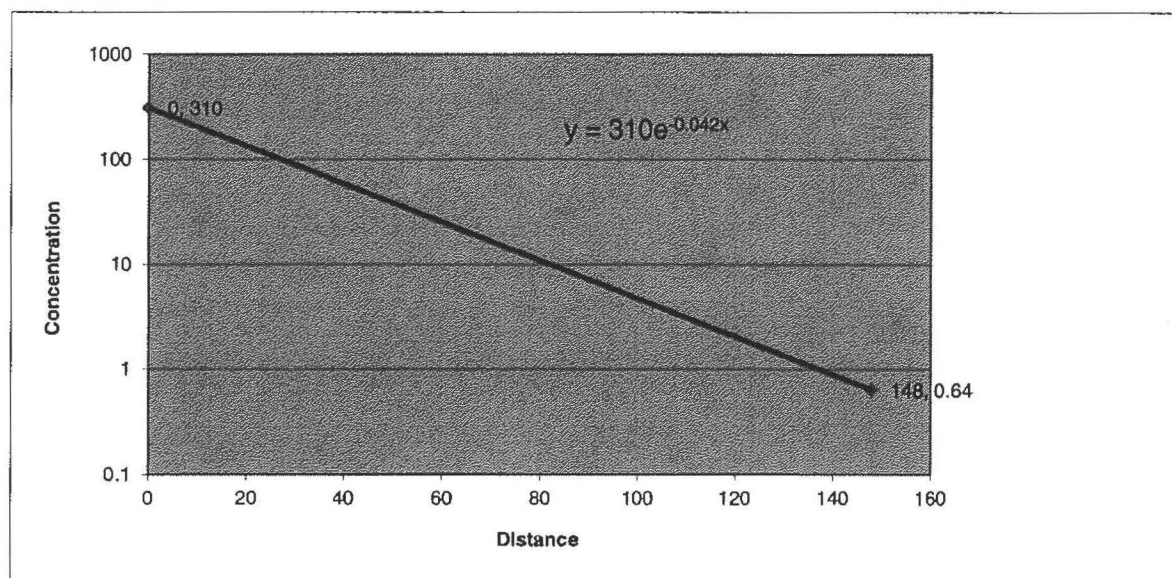
NA - Not applicable, calculated concentration level less than MCL

BULK ATTENUATION RATE CALCULATION FOR CIS-1,2-DICHLOROETHYLENE IN PLUME TILL WELLS

Monitoring Well	Feet from Source	(ug/L)	
MW-13 (source)	0	310	
MW-23B	148	0.64	RL

Slope	Seepage Velocity (Feet per Day)	k	Retardation Factor
0.042	0.011	0.0005	1

Contour Interval (ug/L)	Distance from Source (Feet)	Distance along plume CL (from zero point)
70	35.43	139.83
100	26.94	131.34
1000	NA	



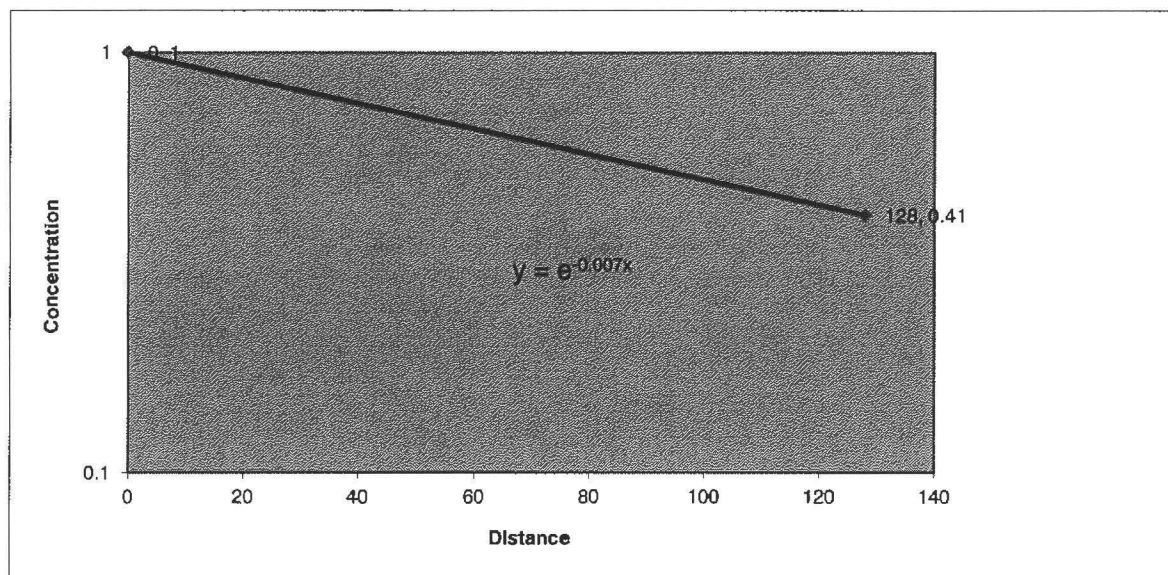
Notes:

- k - Concentration vs. Distance rate constant
- Seepage Velocity - calculated from June 2011 water levels
- Retardation Factor - assumed to be 1 to be conservative
- RL - Reporting Limit
- J - Concentration is estimated or detected below RL
- NA - Not applicable
- CL - Centerline
- The higher result of MW-13 and MW-13 Dup was used

BULK ATTENUATION RATE CALCULATION FOR METHYLENE CHLORIDE IN PLUME FILL WELLS

Monitoring Well	Feet from Source	(ug/L)	
MW-10A	NA	0.41	RL
MW-13A (source)	0	1	RL
MW-23A	128	0.41	RL
Slope	Seepage Velocity (Feet per Day)	k	Retardation Factor
0.007	0.017	0.0001	1

Contour Interval (ug/L)	Distance from Source (Feet)
5	NA
10	NA
100	NA
1000	NA



Notes:

k - Concentration vs. Distance rate constant

Seepage Velocity - calculated from June 2011 water levels

Retardation Factor - assumed to be 1 to be conservative

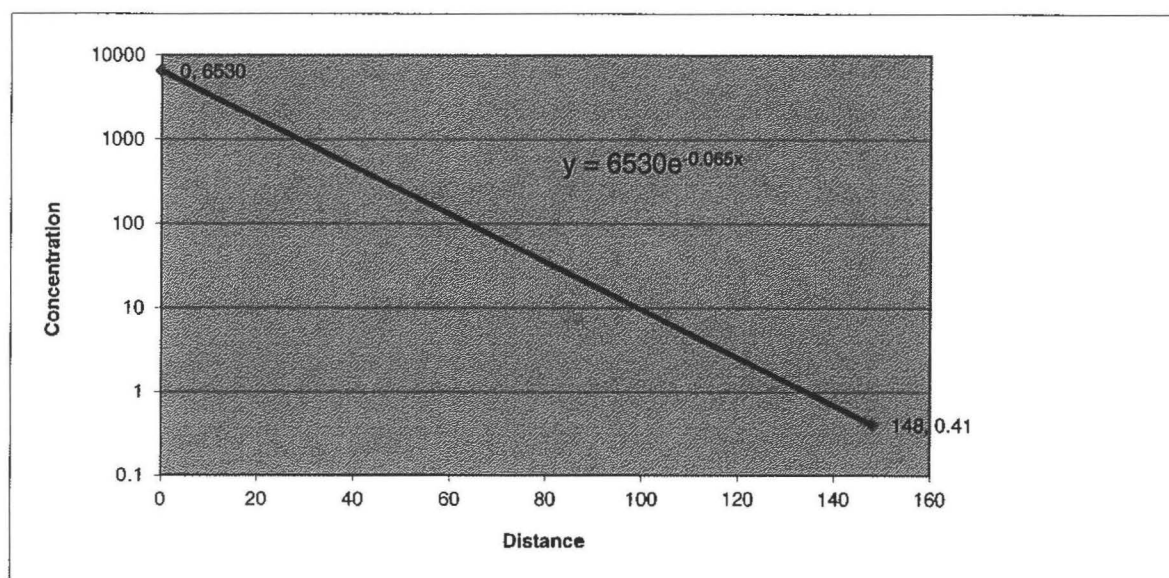
RL - Reporting Limit

NA - Not applicable, calculated concentration level less than MCL

BULK ATTENUATION RATE CALCULATION FOR METHYLENE CHLORIDE IN PLUME TILL WELLS

Monitoring Well	Feet from Source	(ug/L)	
MW-13 (source)	0	6530	
MW-23B	148	0.41	RL
Slope	Seepage Velocity (Feet per Day)	k	Retardation Factor
0.065	0.011	0.0007	1

Contour Interval (ug/L)	Distance from Source (Feet)	Distance along plume CL (from zero point)
5	110.38	214.78
10	99.72	204.12
100	64.29	168.69
1000	28.87	133.27



Notes:

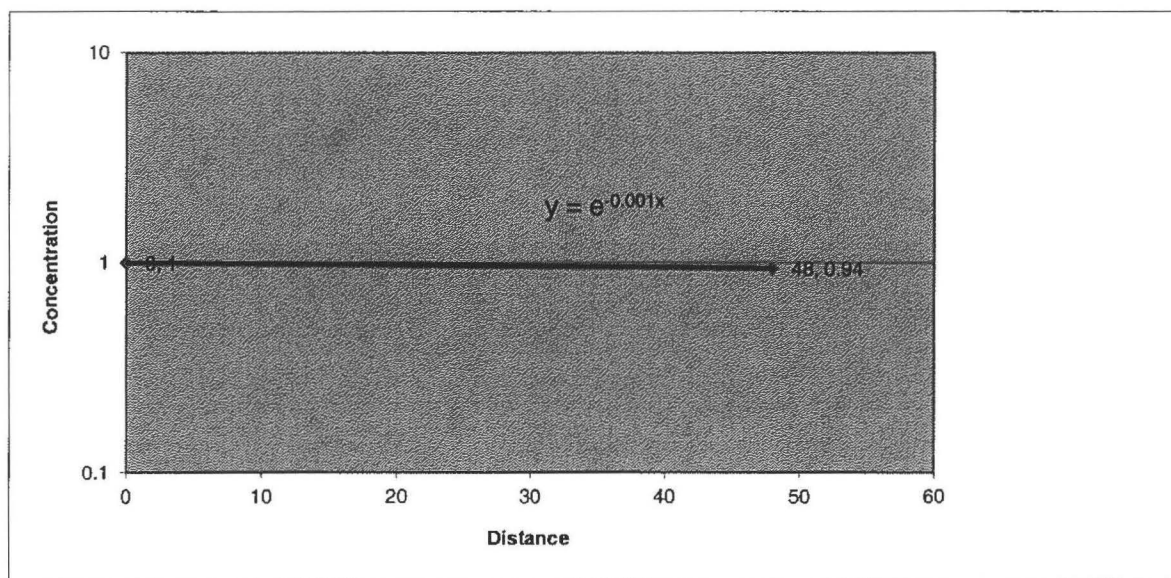
- k - Concentration vs. Distance rate constant
- Seepage Velocity - calculated from June 2011 water levels
- Retardation Factor - assumed to be 1 to be conservative
- RL - Reporting Limit
- J - Concentration is estimated or detected below RL
- CL - Centerline
- The higher result of MW-13 and MW-13 Dup was used

BULK ATTENUATION RATE CALCULATION FOR VINYL CHLORIDE IN PLUME FILL WELLS

Monitoring Well	Feet from Source	(ug/L)	
MW-10A (source)	0	1	RL
MW-13A	48	0.94	J

Slope	Seepage Velocity (Feet per Day)	k	Retardation Factor
0.001	0.017	0.0000	1

Contour Interval (ug/L)	Distance from Source (Feet)
2	NA
10	NA



Notes:

k - Concentration vs. Distance rate constant

Seepage Velocity - calculated from June 2011 water levels

Retardation Factor - assumed to be 1 to be conservative

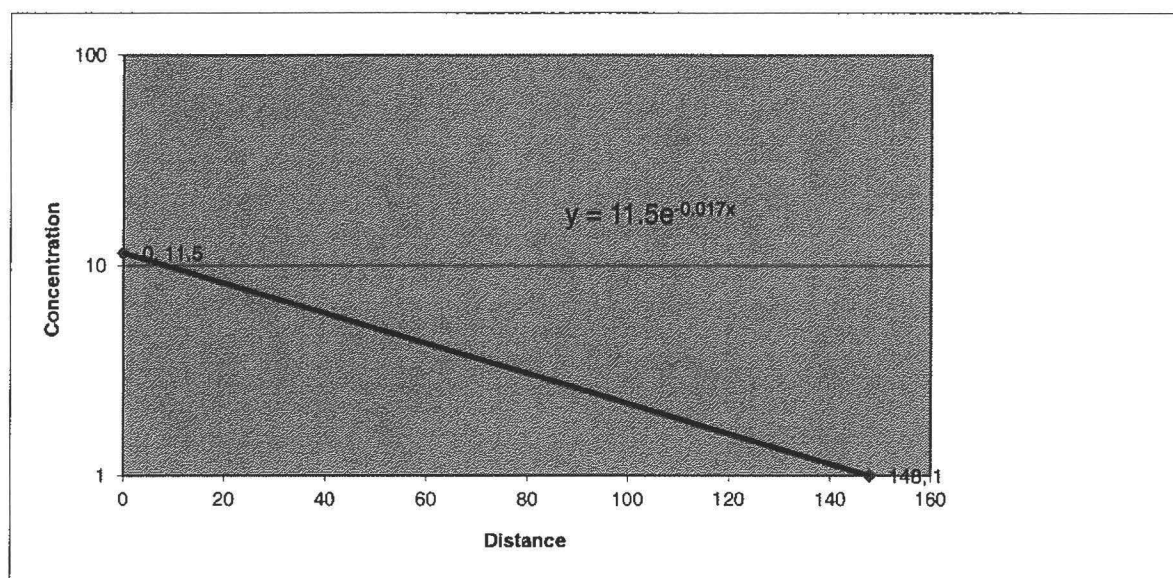
RL - Reporting Limit

NA - Not applicable, calculated concentration level less than MCL

BULK ATTENUATION RATE CALCULATION FOR VINYL CHLORIDE IN PLUME TILL WELLS

Monitoring Well	Feet from Source	(ug/L)	
MW-10	NA	1	RL
MW-13 (source)	0	11.5	
MW-23B	148	1	RL
Slope	Seepage Velocity (Feet per Day)	k	Retardation Factor
0.017	0.011	0.0002	1

Contour Interval (ug/L)	Distance from Source (Feet)	Distance along plume CL (from zero point)
2	102.89	207.29
10	NA	
100	NA	



Notes:

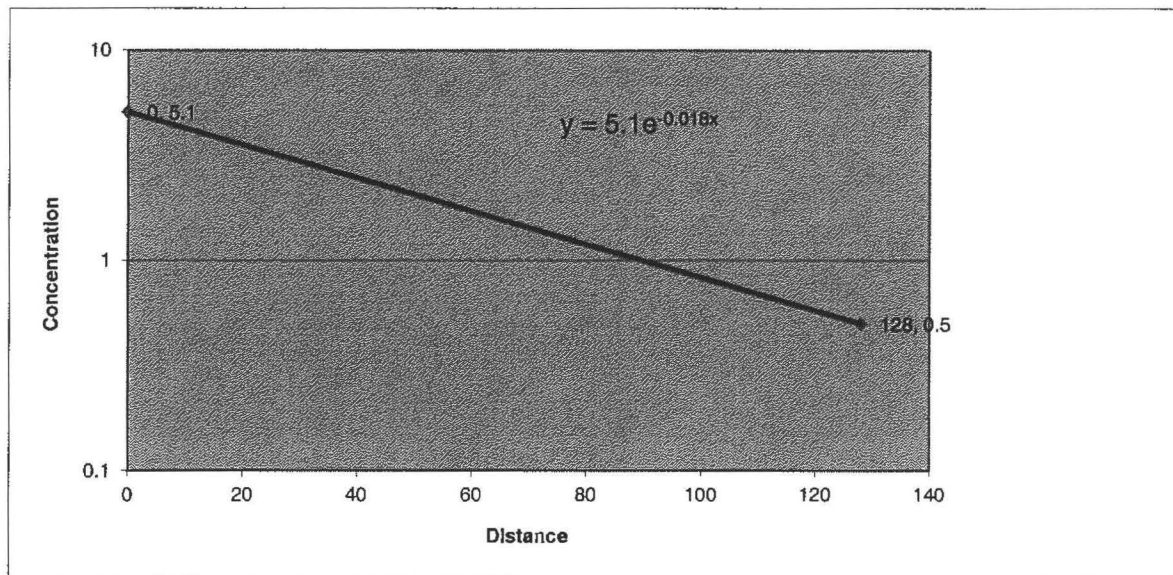
- k - Concentration vs. Distance rate constant
- Seepage Velocity - calculated from June 2011 water levels
- Retardation Factor - assumed to be 1 to be conservative
- RL - Reporting Limit
- NA - Not applicable
- CL - Centerline
- The higher result of MW-13 and MW-13 Dup was used

BULK ATTENUATION RATE CALCULATION FOR BTEX IN PLUME FILL WELLS

Monitoring Well	Feet from Source	(ug/L)	
MW-13A (source)	0	5.1	Benzene (4.3) and xylene (0.81) only detect
MW-23A	128	0.5	All NDs, used benzene RL

Slope	Seepage Velocity (Feet per Day)	k	Retardation Factor
0.018	0.017	0.0003	1

Contour Interval (ug/L)	Distance from Source (Feet)	Distance along plume CL (from zero point)
5	1.10	116.80
10	NA	
100	NA	
1000	NA	



Notes:

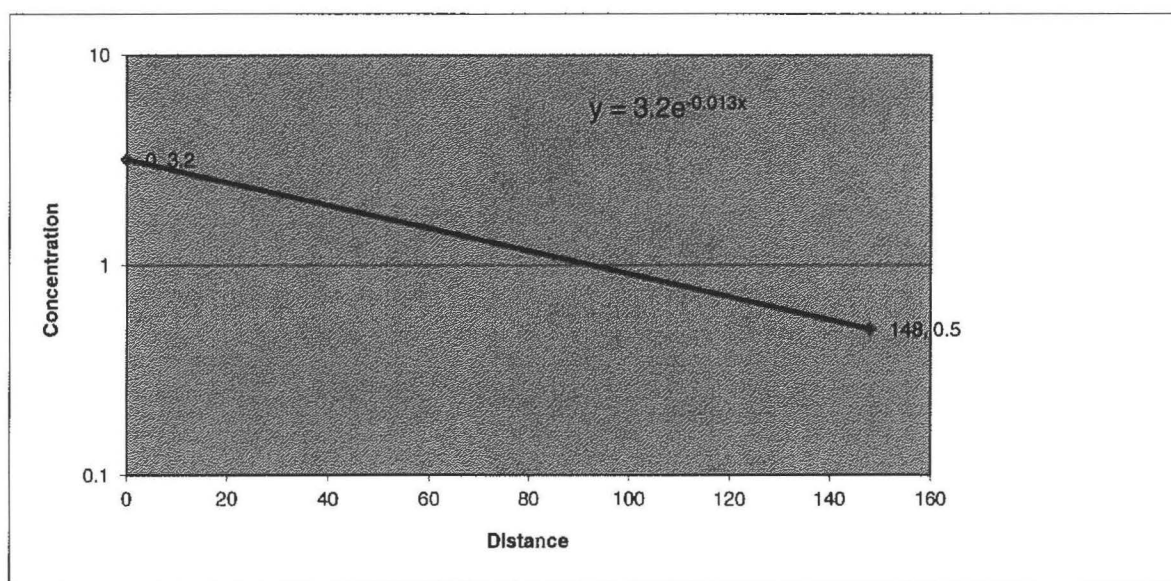
- k - Concentration vs. Distance rate constant
- Seepage Velocity - calculated from June 2011 water levels
- Retardation Factor - assumed to be 1 to be conservative
- RL - Reporting Limit
- NA - Not applicable
- CL - Centerline

BULK ATTENUATION RATE CALCULATION FOR BTEX IN PLUME TILL WELLS

Monitoring Well	Feet from Source	(ug/L)	
MW-13 (source)	0	3.2	Benzene (2.4), toluene (0.58), ethelbenzene
MW-23B	148	0.5	All NDs, used benzene RL

Slope	Seepage Velocity (Feet per Day)	k	Retardation Factor
0.013	0.011	0.0001	1

Contour Interval (ug/L)	Distance from Source (Feet)	Distance along plume CL (from zero point)
5	-34.33	70.07
10	NA	



Notes:

- k - Concentration vs. Distance rate constant
- Seepage Velocity - calculated from June 2011 water levels
- Retardation Factor - assumed to be 1 to be conservative
- RL - Reporting Limit
- NA - Not applicable
- CL - Centerline